TITANS OF THE SOIL

Great Builders of Agriculture

EDWARD JEROME DIES

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—Edward Jerome Dies

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FOOD AND FREEDOM

Two opposing laws seem to me now in contest.... The one places a single life above all victories, the other sacrifices hundreds of thousands of lives to the ambition of a single individual.... Which of these laws will prevail, God only knows. But of this we may be sure, that science, in obeying the laws of humanity, will always labor to enlarge the frontiers of life.

—Louis Pasteur

MAN'S STRUGGLE TO PRODUCE FOOD HAS BEEN as unending as the tides of the sea. This struggle has been intertwined with his everlasting crusade for freedom of body and soul. Production of food has exerted an immense influence upon the course of human destiny. Through all the many centuries of record, every forward impulse of civilization has been coincident with a more abundant food supply.

Historians place the cultivation of cereal grains as far back as ten thousand years before the birth of Christ. In those dim and misty times wheat, barley, and millet were grown in Mesopotamia, the land between the rivers Tigris and Euphrates. At the dawn of history the Nile Valley rivaled Mesopotamia in fertility and productivity, and those two lands became the cradles of western civilization.

Centuries after the tribal hunters had settled down to the growing of food, farming methods still were primitive beyond belief. Much later in Egypt cultivation methods included plowing with a sharpened bent stick drawn by oxen. Land was irrigated from wells by means of a water wheel operated by oxen, and in many instances water was carried in hide buckets to points distant from the Nile and poured with caution and frugality over the seeded areas.

In the tombs of the ancient Egyptians it is revealed that the farmer—a poor serf bound to the land—raised cotton, millet, flax, fruit, and vegetables, and such livestock as beef cattle, milk cows, sheep, asses, and goats. As the centuries flowed along, and Greece

conquered the ancient world, and the Roman Empire later absorbed the entire Mediterranean Basin, the expanding crops of the lowly farmer paid for palaces and temples and supported great armies.

Under the old Roman ideal of a free citizenry and free trade, a rising prosperity was based largely upon farming and stock raising. In this comparatively brief period, men throughout the vast stretches of empire raised their eyes and looked with hope to the future.

But Rome reached its high point under Caesar Augustus, the first Roman Emperor. A gradual deterioration set in as force of arms became the arbiter of man's destiny. Tax burdens weighed heavily, coinage was debased, and emperor after emperor was removed by the army.

A strong man, a man strong enough to control the state, came into power in the third century, A.D. Under the heavy hand of this Diocletian, the tax burden became intolerable, and his centralized government transformed free farmers back into serfs who slaved out their lives for absent landlords.

As happens to "strong" men who set themselves up over human rights, Emperor Diocletian was forced to abdicate in the course of time, and was followed by Constantine the Great, whose greatness consisted in destroying the last flickering spark of freedom and opening up the dismal road to the dark days of the Middle Ages.

Onward moved the long stream of history, with an agricultural population that was kept ignorant and dirty in its abject misery. Across most of the continent the hungry and tattered farm population of medieval Europe existed in a condition of slavery and eked out a living on small plots of ground allowed them by landowners.

Yet the gains from their sweat and struggle and suffering in medieval times largely paid for the glittering pageantry of brilliant courts, armored knights, beautiful women, and costly wars and crusades. Most people stumbled along as best they could in those centuries after the fall of the Roman Empire. Culture was for the most part forgotten; the barons set up castles and warred on each other, and the serfs of the fields prayed to their gods for more food.

It was not until the fifteenth century, the period called the Renaissance, that the unquenchable flame of the human spirit began burning brightly again. In this rebirth of Europe men were dreaming of a better way of life; they revived the arts; a new thirst for knowledge spread across the land.

In England the Renaissance reached the apex of its glories during the reign of the virgin queen, Elizabeth (1558-1603). The period constituted a highlight in English history. The tradesman prospered, the seaman prospered, the noble lord lived like a lord, the sculptor found new honor in his chisel and mallet, and the artist in his brush; poets wrote verse that made them immortal.

But the farmer, producing more food, yet always last to share in a wave of prosperity, took faltering steps forward, only to be pushed and jostled back to the rear of the line. Some independent farmers—comparatively few—were able to live comfortably by dint of long hours in the field with their wives and children. But on the large estates the record is one of misery for the tenant farmer, misery born of selfishness and intensified by lack of laws based on the eternal principle of justice.

A day came when fewer and fewer tenants were needed. The profit from sheep had begun to decline, and so the big landowners had expanded the cultivation of wheat over wider and wider areas and had touched ever higher dividends. Those tenants who were permitted to remain were pinched to a scant existence, while the vast number of dispossessed roamed the countryside, ragged and forlorn, finally moving in upon the cities of England in search of some of the food they had grown.

It was fortunate that at about this time the first stirrings of England's industrial revolution were felt and substantial numbers of the cast-off tillers of the soil were able to turn their hands to mill and factory. Even so, the transition left every rural community burdened with support of the poor; in fact, poor relief plagued England's rulers for two hundred years.

The first settlers in Virginia, who pre-dated the Pilgrims, did not come here in search of rich land to cultivate, but in quest of gold. Their minds had been fired by the thrilling tales of boundless riches carried back to England by daring explorers of the Southeastern seaboard.

On the banks of the James River the London Company landed these exploiters in 1607. Before a year had run out, their dreams of gold had been shattered, and it took all the genius of Captain John Smith to hold them together. They toyed with agriculture—through dire necessity—and were preparing to return homeward three years after arrival when the new governor, Lord Delaware, suddenly appeared at the mouth of the James, inspired hope, and deftly turned the tide.

In the course of a few years commercial plantations began to rise, and the flow of new colonists and their servants grew steadily. After a lapse of six years land was given to individuals for many miles inland from the banks of the James and the Appomattox rivers.

A new solid prosperity, which exceeded the dreams of the gold hunters, developed from the single plant of tobacco, for which the soil and climate of Virginia were ideal. Ships laden with hogsheads of the plant returned to England, and soon all Europe was finding new solace in the "weed," and poets were tossing off rhymes about the divine and holy nicotine.

But plantations produced more than the single money crop of tobacco, for they were of necessity self-supporting; they planted corn and flax and hay and raised cattle and horses. Their freemen and slaves and indentured servants were well fed and well clothed. By 1700 Virginia had become a sound agricultural community.

When the Pilgrims made their historic landing on Plymouth Rock in 1620, the blasts of winter were beginning to be felt. It was a bitter winter, and the group lived on the ship's meager supplies and on what game they could kill. Despite the horrors of the winter, and the death toll in their ranks, none returned to England when the Mayflower sailed in the spring. From friendly Indians they had learned how to find berries in the forest, how to stalk wild game, and how to grow Indian corn. The next year's crops of corn and barley were sufficient to warrant the decree of the first Thanksgiving.

Their community farming was followed by the designation of certain plots of land to individuals, and still later, in 1627, a cow and two goats, offspring of livestock from England, were assigned each thirteen persons. Life was hard and bitter, but the Pilgrims

rejoiced in their new religious freedom and in their privilege of drawing a living from the soil.

What the Pilgrims attained in the face of austerity had a profound influence in the old world. Their deeds lighted a lamp that guided men across the turbulent sea in tiny ships, men ready to lay siege to the wilderness and embrace all its hardships, in the single hope of gaining freedom and rising over poverty and oppression.

To our eastern shores the human tide continued to flow, and by the time the thirteen colonies had become the thirteen United States the better farm lands east of the Alleghenies had been settled. In 1790, says the Department of Agriculture, the settled area of the country extended westward an average of 255 miles, and 90 per cent of the gainfully employed were engaged in agriculture.

Farmers of those days needed relatively few things that required cash. The famous French gourmand, Jean Anthelme Brillat-Savarin, wrote of a bounteous meal with a Connecticut farmer in 1794, at the end of which his host said:

"You behold in me, sir, a happy man, if there is one on earth. Everything you see around you, and what you have seen in my house, is produced on my farm. These stockings have been knitted by my daughters. My shoes and my clothes come from my herds; they, with my garden and my farmyard, supply me with substantial food. In Connecticut there are thousands of farmers quite as content as myself, and whose doors, like mine, are never locked.... All this is due to the liberty we have won by arms and established in good laws. I am master of my house."

Daniel Boone and other frontiersmen who had dared to cross the mountains had brought back stories of rich lands, broad and level and crying out for the hand of the plowman. Hardy souls began moving westward in the course of time, many of them soldiers of the Continental army who were given land instead of money by a new and financially embarrassed government. Through gaps in the hills, the thin line of frontier folks became a cavalcade.

Into the family of states Kentucky was admitted in 1792, and Tennessee in 1796, and the western march continued; caravans of rattling wagons, ballooned over with white canvas, snaked their

way into the midwest prairie lands, long before the coming of the steel plow and the reaper and the thresher, and while history was being written with tomahawks and pistols.

This opening up of the agricultural west is a monumental story, a story of privation, isolation, and animal drudgery, not only for men, but also for the prairie mothers who lived in hay-roofed huts and sod houses and who plowed and sowed and watered stock and nursed children and sometimes buried them under ice-sheeted plains.

It is a story of Indian war-whoops that mingled with the ring of axes in the forest and the whir of spinning wheels in cabins. It is a record of daring men, plowmen, who in the end scaled the high Rockies in their westward drive. In the whole record of agriculture there is no more dramatic chapter.

The farmer made America great. His tiny settlements became villages, villages became towns, and then there arose the towering cities across a continent of fertile croplands. The virgin forests were there for the builders, the streams to generate power, and ore for the smelters.

It was the farmer who sowed the seeds that produced the swelling crops of grain and potatoes and cotton and faith and love of liberty. And at length America, his land of freedom, emerged from the wilderness the strongest nation on the face of the earth.

In creation of our mammoth agricultural empire, industrial development kept pace with the mighty garden stretching across the land. Builders of canals and railroads and mills and factories made their lasting contributions. So did the scientist, peering into his test tubes in the quiet of his laboratory, and the inventor puttering away in his little shop.

There were the men, too, who fought for the creation of our now great Department of Agriculture, our incomparable land-grant colleges and experiment stations, and the far-flung agricultural extension service.

Then there were the plant explorers, roaming distant lands in search of new types and varieties of seeds adaptable to this soil and climate, and a few broad-visioned legislators who fought doggedly for equitable laws to widen and brighten the horizon of the food producer.

It is not the purpose of this book to set forth the history of

American agriculture, but rather to sketch in broad outline the lives and work of a selected group of men, each of whom, in his own way, made a priceless and enduring contribution to the advancement of our agriculture and, in many instances, to world agriculture.

Let it not be said that all these men are nominated as the greatest benefactors of the American farmer. Their names were selected from lists of suggestions which the author obtained from leading authorities in their varied fields in a number of great universities and in the federal Department of Agriculture.

There may be men who made more admirable contributions, for it is a neat point, always susceptible of argument. But of this we may be sure: to each of the following men the American farmer—and indeed every American—owes a reverent debt of gratitude.

GEORGE WASHINGTON

Farmer of Mount Vernon

GEORGE WASHINGTON

Born on Wakefield Plantation, Westmoreland County, Virginia, February 22, 1732.
Became explorer and surveyor for Lord Fairfax, 1748.
Inherited Mount Vernon, 1752.
Served in Virginia Colonial Militia, 1752-58.
Married Martha Custis, January 6, 1759.
Began fertilizer research and growing alfalfa, 1760-61.
Intensified research in scientific grain growing, 1763.
Developed own methods of grafting orchard trees, 1765-70.
Restricted tobacco growing because of soil depletion, 1770.
Developed diversified farming and crop rotation, 1768-74.
Commander-in-Chief Colonial Forces, 1775-83.
Invented combination plow and drill seeder, 1786.
President of the United States, 1789-97.
Died December 14, 1799.

WASHINGTON HAD UNFLAGGING FAITH IN THE land. He was a great farmer, for his time, just as he was a great patriot, soldier, and statesman. In 1788, the year before he became President, he wrote:

"I am led to reflect how much more delightful to an undebauched mind is the task of making improvements to the earth, than all the vainglory which can be acquired from ravaging it, by the most uninterrupted career of conquests."

His aspiration was to be a good farmer and to point the way for others. To this end he toiled as diligently in the green fields of Mount Vernon as on the scarlet fields of Brandywine.

In the dismal period of the Revolutionary War he dreamed of returning to his Virginia Hills, which he glimpsed but once in six years; and when later he was again called to the service of his country, this time as President, the bright patches of life were the hours spent at his Manor House on the Potomac.

His personal correspondence and lengthy diaries mirror a spirit of scientific research that is a constant source of wonderment to present-day specialists.

Washington was glad to earn a doubloon a day as a surveyor in his early youth. He died the richest man in America. Early he had developed a land hunger and at one time owned some 70,000 acres in nearly two score communities. But his farming efforts were concentrated upon the Mount Vernon estate of five farms, comprising 8,000 acres, half of it tillable, with a fishery, a ferry, and two grist mills.

It is true that Washington's estate was increased by inheritance. His father, Augustine Washington, a planter, had left Mount Vernon to George's older half-brother Lawrence, a high-minded man of warm affection. At Lawrence's death in 1752 Mount Vernon passed along to George. Marriage to Martha Custis in 1759, when George was nearly twenty-seven, added a substantial sum to assets, but this was largely wiped out in wartime currency depreciation.

There were times when Washington was actually pinched for ready cash in the operation of his five farms, with their several hundred slaves and white workers who must be fed and clothed and housed the year round. It is recorded, for example, that because of hard times he was compelled to borrow funds for his journey to New York to be inaugurated President.

But evidence abounds that generally he made money on his Mount Vernon farms when not absent in government service—profits far greater than those of other Virginians similarly engaged.

This he did by stubborn and painstaking experimentation. He was forever striving to conserve his soil and check erosion. He diversified his crops, and he practiced crop rotation. He pondered long and deeply on new methods of cultivation, and he pioneered in the use of new machinery. He possessed to a high degree the characteristics of an astute inventor and lacked only time.

Up and in the saddle by sunrise, Washington would canter about his fields issuing orders for the day. As a young man he was six feet two inches tall, weighed 175 pounds, and usually wore his chestnut hair in a queue; he had large hands and feet, and a pleasant countenance, later marred by lines of care and marks of smallpox.

Like other planters in Tidewater Virginia in the 1760's, Washington raised tobacco. It had what meat and grain did not have—a ready market in Europe. In England a pound of tobacco often brought as much as a bushel of wheat, yet cost but a slight fraction as much to ship.

But tobacco growing was very soil-depleting. Planters simply opened new acreage when the soil of old fields was exhausted, for as Thomas Jefferson observed, it was cheaper to buy a new acre than to fertilize an old one. That custom disgusted the prac-

tical Washington. His tobacco growing reached a peak of 89,079 pounds in 1763, and thereafter decreased steadily until it was virtually discontinued. He even warned a tenant against growing more tobacco than was needed for "chewing and smoaking in your own family." Single cropping was not for him.

He experimented endlessly with fertilizers available on the plantation. He mixed with minute care the excrements from various animals, marle from the gullies, and black mold from the creek sides, with soil from his numerous fields. In detail he entered the various concoctions in his diary, related how each of ten mixtures was placed in a separate compartment, and then added:

"In each of these divisions were planted three grains of wheat, three of oats and as many of barley—all at equal distances in rows, and of equal depth (done by a machine made for the purpose)."

Thus did our first scientific farmer seek out the facts. He fought erosion with equal zeal. Each year the rains would wash topsoil down into his "Muddy Hole" farm, and each year he would haul it back to its proper place and, according to Noah Webster, would drink an occasional toast: "Success to the mud."

He carried on lengthy correspondence with the brilliant Arthur Young of London, editor of the *Annals of Agriculture,* whose contributors included William Pitt, with articles on such subjects as deep plowing and storing turnips. Even George III himself wrote in the journal under the pen name of Ralph Robinson.

Through Arthur Young, Washington was able to obtain many types and varieties of seeds. He always warned Young that they should be stored in a part of the boat where over-heating would not occur. For his diversified farming he tried out most of the crops he could learn about. He did very well with alfalfa, brought over from Europe, and continued its growth for many years.

His experiments included red and white clover, winter vetch, rib grass, burnet, sainfoin, buckwheat, and hemp. His determined efforts with cotton proved unavailing.

"The system of agriculture . . . in use in this part of the United States," he wrote as late as 1786, "is as unproductive to the practitioners as it is ruinous to the landholders. Yet it is pertinaciously adhered to. To forsake it . . . requires resolution."

Washington has been called one of the most methodical men

in history. His letters and diaries on farming would tend to prove the point: nothing is vague or trivial, nothing haphazard or incomplete; every plan, every thought, is well rounded and stimulating.

By trial and error he worked out his seven-year crop rotation system and set it all down in the record, along with his detailed weather reports. The fields of his five farms he divided up with a surveyor's accuracy and planned the rotation of each. First he planted wheat. Next year he put in buckwheat, which he plowed under. Then came wheat again, a plant rather hard on the thin soil. For the next three years he planted grass and clover and made his profit on beef and mutton and dairy products. The seventh year he grew corn and potatoes.

Of course the plan was imperfect, but it was remarkable for those times; he was pioneering, breaking new frontiers of agricultural science.

He grew wheat successfully where soil and climate were ill-suited to profitable wheat culture. From distant lands he had gathered seeds and had tested them in experimental plots; he had counted them out, so many seeds to the pound, and so many pounds to be sown to the acre. Nothing was left to chance.

In 1764 he sold and delivered at the Alexandria wharf 257 bushels of wheat. Five years later he loaded at his own dock 6,241 ½ bushels. Thereafter he ground most of his wheat in his own mills and sold the flour to plantations in the West Indies. He rightfully boasted that it was "as good in quality as any produced in America."

For the remainder of his life, on one or another of his Mount Vernon farms, he raised wheat which, by careful attention to seed and cultivation, often weighed over sixty pounds to the bushel.

In livestock breeding he was equally painstaking and progressive. At various times he raised deer, turkeys, hogs, cattle, and geese, but his chief interest was in sheep, mules, and horses. His horses totaled 130 at one time, including Blewskin and Nelson, who bore their bold master through the smoke of many battles and in old age grazed the green hills in contentment.

Washington had no time for the razorback hogs that roamed

the woods. He imported short-legged red swine that could produce ham and bacon and salt pork for his workers and their families, and steadily improved the breed.

The lean and puny sheep with which he started out thrived into a flock of six hundred fat producers of wool and mutton through importation of the English Bakewell breed. Farmer Washington increased wool production to five and a quarter pounds as the average fleece, while his neighbors seldom clipped two pounds.

When he heard that the Spanish mule was a superior draft animal, he began overtures with Madrid. In spite of the law prohibiting exportation of these animals, the King of Spain finally sent him two jacks and two jennets. By his own account, Washington was the first American to raise mules.

In horticulture his efforts were both tireless and profitable. He was an enthusiastic planter of orchard trees, and must have grown peaches as early as 1760, for an entry in his diary on his birthday said: "Laid in part the Worm of a fence round the Peach orchard."

At about this time he had learned how to propagate and "wed" his own trees. On one occasion he records that he grafted forty cherry and twelve plum trees; he grafted quinces on pear and apple stocks, and developed, among other things, an excellent cider crab apple of hardy stock. He planted cuttings of Madeira grapes and, with other types, acquired a productive vineyard. From southern Illinois he obtained pecans and is credited with being the first farmer to cultivate pecan trees.

Washington liked order and beauty and in the late sixties set about to satisfy his esthetic sense by beautifying his grounds. He determined to have around the Manor House every possible specimen of native tree or shrub noted for beauty of form, leaf or flower. Some of the trees he planted are still standing.

In his long absences he fretted no end because his orchards and fields and livestock suffered, in spite of the daily detailed reports required from overseers and his own long weekly letter of precise instructions.

Such a practical mind was impatient with anything short of perfection. This impatience was especially noted in the case of

machinery. With his inventive mind he would remodel an implement or build one to suit his purpose. Soon after settling at Mount Vernon he noted dissatisfaction with a plow, and wrote: "Spent the greater part of the day in making a new plow of my invention.... She answered very well."

Most notable of his inventions was a combination plow and seeder. He had spurned the archaic custom of sowing grain seeds by hand and had pioneered in this country in planting with drilled rows.

His somewhat clumsy invention consisted of a barrel mounted upon a wheeled plow. As the plow moved forward the barrel revolved and out of holes cut or burned in the barrel the seeds were dropped into tubes which ran to the ground. The seed flow could be regulated by decreasing the number of open holes. Behind the drill ran a light harrow which covered the seeds. With persistent refinements the contraption worked splendidly.

Every new tool or implement quickly found its way to Mount Vernon. When few pumps competed with the old oaken bucket, Washington had two excellent ones built under his personal direction.

He had a vision of a farm empire west of the Alleghenies, and he strove to improve transportation facilities between the headwaters of the Potomac River and those of the Ohio in order to open a water lane for the movement of crops.

In his messages on the state of the nation he sought to interest Congress more actively in the welfare of the farmer. In his final message in 1796 he urged the creation of a board of agriculture, but little interest was shown, for he was far ahead of his time.

By his deeds, by his original thinking and experimentation, rather than by laws, he left his mark on agriculture and stands in the forefront of those who aided its progress.

Time has wrought changes at Mount Vernon. Sheds and barns and slave quarters on the farms have mostly disappeared, but the Manor House, with its flowers and trees and birds and spacious lawns, still stands there in all its glory, topping a rise over the Potomac. It is a shrine no man can visit without sensing an uplift of heart and soul.

Strolling beneath the ancient elms and beeches at sunset, one can almost fancy the spirit of the great patriot stepping out upon the broad portico and, with his spy glasses, sweeping the river for ships; or perhaps sitting quietly with his dreams—dreams of a magnificent new land, mighty and dynamic in its eternal liberty. And the phrase of one historian may come to mind:

"Words have yet to be penned that do him justice."

THOMAS JEFFERSON

Farmer of Monticello

THOMAS JEFFERSON

Born at Shadwell, Virginia, April 13, 1743.

Graduated from the College of William and Mary, 1762, and began study of law.

Member of House of Burgesses, 1769-75.

Married Martha Wayles Skelton, January 1, 1772.

Wrote his celebrated "Summary View of the Rights of British America," 1774.

Declaration of Independence, as drafted by Jefferson, adopted July 4, 1776.

Congress adopted his ordinance on western lands, 1784.

Inaugurated President at Washington, D. C., March 4, 1801.

Treaty for Louisiana Territory purchase signed at Paris, 1803.

Retired as President and returned to Monticello, March 4, 1809.

Died at Monticello, July 4, 1826.

THOMAS JEFFERSON, THE APOSTLE OF DEMOCracy, was a devout exponent of the virtues of the farmer. He declared: "Those who labor in the earth are the chosen people of God."

His ideal government would have been that of an agrarian republic. "Cultivators of the earth," he wrote, "are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to the country and wedded to its liberty by the most lasting bonds."

He believed that the man close to the soil, with time to think, was capable of superior judgment: "Take a moral case to a plowman and a professor. The former will decide as well, and often better... because he has not been led astray by artificial rules."

So deep was his admiration for those who till the soil that he often suspected urban dwellers of chicanery and excessive greed. He disliked cities; he favored development of manufacture only to the extent of meeting our country's needs. To develop beyond that would simply increase the nation's dependence on foreign lands.

His praise of the man who worked the fields had a spiritual sincerity, as shown in his tireless life-long struggle to improve the state of agriculture.

Peter Jefferson, father of Thomas, did not acquire his own broad acres among the rich plantations of the Tidewater country, but rather in upland Virginia, where the sturdy, courageous, and independent hillmen were interested first in crops and last in the

niceties of colonial social graces. Thus the associates of young Thomas, by his father's wise choice, were small working farmers rather than great planters and landholders. Their methods were marked by crudeness and simplicity; their problems were varied and numerous. Observance of their tribulations helped to mold Thomas Jefferson's noble philosophy of government.

Peter Jefferson, who had gained some fame in his little upland world by being elected to the House of Burgesses, died at fifty, in 1757, when Thomas was fourteen. The mother of Thomas, a Randolph, had died previously. Henceforth the boy charted his own course.

He decided at seventeen to attend the College of William and Mary at Williamsburg. "It was my good fortune, and that probably fixed the destinies of my life," he wrote, "that Dr. William Small of Scotland was then professor of mathematics, a man profound in the most useful branches of science." Dr. Small doubtless had a decided influence on Jefferson's character and added much to his scientific turn of mind.

It was in 1767, after his admittance to the bar, that Jefferson took charge of the family farms in Albemarle County around Monticello and Shadwell, where he was born. The actual inheritance of the tall, sandy-haired, freckled young man was 1,900 acres. He more than doubled this in five years, with every acre paid for.

Such was his passion for the land that eventually he owned nearly 11,000 acres, of which less than one-fifth was cultivated. Beautiful Monticello, which figured so importantly in the birth of a nation, he designed and built as his home in 1770. His surrounding farms became a small principality of two hundred inhabitants, almost wholly independent of the outside world.

It was to Monticello, today a majestic shrine, that he brought his bride, Martha Skelton, two years later. She was merry and amiable, but suffered ill health in the last of their ten years of married life; four of their six children died within two years after birth, and she herself died in September, 1782. The author of the Declaration of Independence never remarried.

That one man with such slender resources could accomplish what Jefferson did is regarded as one of the miracles of American history. Statesman, architect, scientist, educator, he was first and

foremost a farmer, and it was in that field that he found his greatest happiness. He called agriculture a science of the first order: "It counts among its handmaids . . . chemistry, natural philosophy, mechanics, mathematics, natural history, and botany."

Like Washington, Jefferson detested the predominant single-crop growing of tobacco. By 1812, according to his voluminous Garden Book, thirty-two vegetables were cultivated at Monticello, In addition there were innumerable plants and trees brought from many lands, for he played an important part in world plant migration. From Europe, while serving as Minister to France (1785-89), he sent home seeds, cuttings, and detailed reports on vineyards, orchards, rice milling, silk production, and a variety of other highly important agricultural subjects.

Besides the vegetables grown at Monticello, there were twenty-two crops, including half a dozen different grains, peas, clover, potatoes, cotton, artichokes, lucerne, hay, hemp, and flax. They were Jefferson's answer to the single-crop practitioners. Results of his endless tests and his comprehensive seed-germination research were available to all who were interested. His facile pen spread far and wide the story of field and orchard successes.

Livestock then raised in America was rather nondescript except for a few fine horses. Jefferson helped shake farmers out of their frail and faulty methods. To the day of his death he struggled with the problem of better breeds. His experiments with sheep and with his imported Calcutta hogs brought superior results to his neighbors and later to farmers over far-flung areas.

In his scientific farming he arranged his cultivated lands into four farms, and each farm into seven fields, marking the boundaries with peach trees. In his seven-year rotation program no land was left bare, for he believed the sun "absorbs the nutritious juices of the earth" when soil is left unprotected. He often favored legumes as a covering, contending they would absorb fertility from the atmosphere and enrich the soil.

Religious farmers accepted the blight of pests as an act of God. But not Jefferson. His anti-pest studies covered years; he beat the Hessian fly, a menace to growing wheat, by burning the stubble, a method still in common practice.

Jefferson noted that rainstorms washed both crops and soils down the hillsides of many farms. He attacked the problem and

at length introduced horizontal or terraced plowing. Marked benefits resulted.

In the present age it is rather difficult to picture "the most cultured American of his day" down on his hands and knees in the dirt studying the curves and angles of a plow. But here Jefferson applied the science of physics to a knotty problem and came up with a new moldboard, a moldboard that had the least resistance to the forward movement of the plow. Then he introduced the practice of having the moldboard cast entirely in iron instead of wood. It has been termed the last great fundamental development in the series of old wooden plows. Publication of his invention, on which he took out no patent, centered attention here and in Europe upon the subject of plows and the need of further improvement.

Historians say that Jefferson was not distinguished in imaginative faculties, but his mathematical mind had an insatiable appetite for facts. "Nature intended me for the tranquil pursuits of science," the statesman once wrote, but this science most frequently pointed to agriculture.

His basic political philosophy was early disclosed when he was a member of the Virginia House. With one bill he sought repeal of the laws of entail to prevent the accumulation and perpetuation of wealth in select families. Another was aimed at the custom of primogeniture, which passed estates intact to the eldest son. Plainly his intent was to break up the great estates given as land grants by English kings to various favorites and to divert such lands into the hands of small farmers where he felt they belonged.

In Virginia religion was a political monopoly of the Church of England; so a third bill of his decreed religious liberty.

Shortly before his death, Jefferson designated the Declaration of Independence, the Virginia statute of religious freedom, and the founding of the University of Virginia as his chief contributions to mankind. The fact that he was third President of the United States seemed of no apparent consequence.

In retrospect it is clear that in naming these three attainments his judgment of his services was as unerring as had been his vision of his country's life. The first of the three provided a creed for democracy. The second was a milestone in the age-old struggle

to separate civil governments from religious domination. The third, the founding of the University, pointed up Jefferson's unshakable conviction that if democracy is to survive it must be an intelligent democracy.

All within his power was done to further the cause of general education. He projected a curriculum embracing all branches of human knowledge. The sovereignty of reason was to be enthroned and all things subjected to sweeping analysis before acceptance.

To the framework of the agricultural empire he made other notable contributions. After independence was recognized there arose the problem of how the new nation should govern its public domain. Jefferson headed a committee to draft a plan. His report became the Ordinance of 1784, grounded in the principle that regions beyond the Alleghenies were to have restricted rights of self-government while sparsely settled. Later they would be admitted to the Union on equal terms with the thirteen original states. It was a light to the future, just as was the next year's Ordinance on the principles of the American land policy, which he helped to draw up.

It is crystal clear that Jefferson was an eternal enemy of centralized power. This is reflected over and over again in the remaining sixteen thousand letters which are but a part of the record. Yet he could even waive this high principle for the good of his cherished agrarians, as indeed he did in the case of the Louisiana Purchase.

In regaining the Louisiana Territory from Spain, Napoleon exercised control over the New Orleans port through which passed three-eighths of America's farm products. Two years later, in 1802, the mouth of the Mississippi was closed to American ships. Quick action was necessary. President Jefferson sent James Monroe to France to try to buy New Orleans and the Florida provinces for two million dollars.

Napoleon's minister, the crafty Talleyrand, was not interested. But it developed later that Napoleon had cooled on colonial ventures because he planned war with England. So one day Talleyrand asked, casually, how much would be offered for the whole of Louisiana. The deal was closed for fifteen million dollars—a territory comprising what are now fourteen states. An amazing

bargain. But Jefferson had to beg his friends in Congress to raise no "constitutional difficulties." Historians have been rough on him for this venture in executive autocracy.

When his heart was heavy with cares of state, Jefferson turned to the music of his violin, or to one of the other arts. As an architect he was noteworthy. His design for the Richmond State House set a pattern for American public buildings for a century. His treasured Monticello and the famous quadrangle at the University of Virginia are regarded as distinct contributions to American architecture.

To both Jefferson and John Adams their correspondence was a consolation in old age. They had been bitter enemies since 1796, when they had run against each other for the presidency and Adams had won; in 1800 they had run again and Jefferson had been the victor.

One day Adams broke the ice of their long silence with a friendly letter saying that he was sending Jefferson some pieces of homespun; and within the hour Jefferson had begun his reply. He waxed sentimental about how the two of them had pulled together courageously for the country's good in years gone by and how only seven of the signers of the Declaration of Independence were still among the living.

"You ask," wrote Jefferson in one letter of this intensely interesting correspondence of fourteen years, "if I would agree to live my seventy-three years over again. To which I say, yea. I think with you that it is a good world on the whole; that it has been framed on a principle of benevolence, and more pleasure than pain dealt out to us.... How much pain have cost us the evils which have never happened!"

Jefferson retained his robust health, sound teeth, and good eyesight for all of his eighty-three years. But the tranquillity which he had anticipated in the twilight of life was absent. Monticello was there in all its quiet beauty; he could tramp and ride horses among the foothills of his glorious Blue Ridge Mountains. But debt made his days uneasy and his nights sleepless. It was caused by bad economic conditions, by long absences in which his lands suffered, by devotion to problems of state and to the progress of agriculture, and, last but not least, by the never-ending parade of guests who for long periods required the services of forty house

servants. At the end, the debt was forty thousand dollars, and within a year of his death the estate was sold over the head of Martha, his only surviving child.

Jefferson had hoped to live until the fiftieth anniversary of the signing of the Declaration of Independence. That day dawned on July 4, 1826. Before sundown one of the most singular coincidences in our history had occurred. Both Jefferson and Adams had died.

Jefferson's statute of religious freedom long had made him a target of the clergy, who termed him an atheist and an infidel. Yet his faith was deep; he had even prepared his own bible which he titled "The Philosophy of Jesus." And in his dying hour, after having bade his family farewell, he was heard to murmur:

"Lord, now lettest Thou Thy servant depart in peace."

ELKANAH WATSON

Father of State Fairs

ELKANAH WATSON

Born in Plymouth, Massachusetts, January 22, 1758.
Educated at leading local school.
Apprenticed to John Brown of Providence, Rhode Island, 1773.
Toured the Southern Colonies in 1777 and 1778.
Carried letters of peace to London, 1782.
Made and lost a fortune in France by 1783.
Leading citizen of Albany, New York, 1790-1807.
Moved to farm near Pittsfield, Massachusetts, 1807.
Originated county fair and cattle show, 1811.
Returned to upper New York, 1818.
Fostered agricultural advancement, 1818-42.
Died at Port Kent, New York, December 5, 1842.

A LITTLE GROUP OF FARMERS STOOD IN THE shade of a lofty elm tree and cheered. They had been staring at a pair of fine Merino sheep imported from France and listening to a rousing talk by Elkanah Watson. The year was 1807.

"Why shouldn't America grow its own wool?" Watson shouted.

"And many other things, too," bellowed a rugged farmer who had fought in the Revolutionary War. "Let's really be independent!"

Watson continued: "If my two sheep can excite so much interest here in this public square, what would be the effect of a large display of many farm animals?" More cheering, and cries of "let's have it!"

Farmers returned to their homes around Pittsfield, Massachusetts, and Watson, through his Berkshire Agricultural Society, began planning for the now historic exhibition which was held four years later and which created national interest.

Of that first real agricultural fair Watson wrote an exciting description. He pictured the half-mile-long procession of "sixty-nine oxen, connected by chains, drawing a plow held by the oldest man in the county; a band of music; the Society bearing ensigns, each member with a badge of wheat in his hat; a platform upon wheels, drawn by oxen, bearing a broadcloth loom and spinning jenny, both in operation. . . ."

There, at that event in September of 1811, were born our splendid farm exhibits, fostered by Elkanah Watson, one of the great men of agriculture and father of the state fair.

By an irresistible force farmers were drawn to these events of competition; they vied with each other for the highly coveted awards for excellence of livestock and grains and other products of field and orchard. With growth of the country, the movement spread until now more than sixty million people attend the 2,000 agricultural fairs held in this country each year. The enthralled farmer is taught to observe; he is persuaded to go home and try out new methods of production. The shining results have been of immeasurable value in the upbuilding of the national economy.

Elkanah Watson's boyhood and youth were full of thrilling adventure, the sort of adventure most red-blooded boys dream of and few ever attain. He lived in an age of adventure, when life was cheap.

Early in the century the family had been rich, but little material wealth remained when Elkanah was born on January 22, 1758, in Plymouth, Massachusetts, where the first Watson had arrived in 1632. On the side of his mother, Patience Marston Watson, he was a sixth-generation descendant of Edward Winslow, Mayflower passenger and third governor of Plymouth Colony.

He attended grammar school under two men who later became Revolutionary leaders, Alexander Scammell and Peleg Wadsworth, and acquired an overpowering desire for travel. But at fifteen, his father, also named Elkanah, bound him out to John Brown, a wealthy lawyer and merchant of Providence, who was busily opposing the Crown, and whose family, incidentally, founded Brown University.

Soon things began to happen. The Colonials held the Boston Tea Party, and young Watson joined Colonel Nightingale's cadet company. Later he sought his release from Brown to join the Colonial Army besieging Boston. But permission was refused. "There are more important jobs for this lad," Brown told the elder Watson. "He's brave as a hawk.... We must deliver gunpowder at all costs."

And gunpowder young Watson delivered, with the stealth and cunning of an Indian who knows his woods, and with neat strategy and resourcefulness. He got one consignment safely through to George Washington at Cambridge, Massachusetts, in July of 1775, and he and the General struck up a lifetime friendship.

It was only a short time later that two of King George's twenty-gun ships captured a Colonial flour vessel along with its owner, the wealthy and daring John Brown. On learning the news young Watson leaped into his saddle and galloped like mad from Providence, Rhode Island, to Plymouth, Massachusetts, a distance of forty-five miles, changing horses several times en route.

In the dead of night the village was startled by the cries of the lone horseman whose black mount was flecked with foam. Windows flew open and fowling pieces were snatched from their racks. The men gathered and listened to the breathless boy unfold a rescue plan. It involved the fitting out of two armed schooners to surprise the British as they sailed the captive flour ship around Cape Cod for Boston.

Twelve hours later the two dilapidated fishing schooners, with two old cannon each, sailed forth. Seventeen-year-old Watson was aboard the lead ship, "the first American vessel to challenge the British flag."

The dare-devil ten-day cruise almost proved disastrous, for Watson's craft barely escaped a trap. But the brazen gesture, coupled with powerful overtures, brought Brown's release.

Adventure? For young Watson it was only just beginning. Brown wanted to shift some capital to safer quarters as the British fleet approached Philadelphia and as Burgoyne edged in on Albany. Into the lining of Watson's clothes was sewed $50,000, with instructions to ride hard through to Charleston, South Carolina, and invest it. The ride of twelve hundred miles took seventy exciting days of dodging the British, the Tories, and the rebellious slaves. But the mission was a success; moreover, Watson filled a notebook with valuable facts on cities, rivers, forests, and people, but mostly on crops and how they were grown. He noted visits with General LaFayette and with George Washington's mother.

When his apprenticeship ended at twenty-one, he was sent to Paris with funds and dispatches for Benjamin Franklin, with whom he spent several weeks. He was "struck by the charm of Queen Marie Antoinette." At Nantes he fell in with M. Cossoul and they launched a mercantile business that built up to six ships and 300 seamen and a $200,000 fortune in three years. But the cyclonic post-war panic swept away both business and fortune.

Young Watson was chosen to carry the letters of peace from

Paris to London in 1782 and on December 5 he stood beside Admiral Lord Howe near the throne while King George III read his speech freeing the American Colonies. Edmund Burke introduced him as "a messenger of peace" in the House of Commons. During his subsequent tour of England, he packed notebooks with facts on farming and canals. John Singleton Copley did a portrait painting of Watson, after the King's speech, filling in the background with American symbols. Watson's white shirt and lace neckerchief and ruffled cuffs complemented his bright red coat. He was a tall, strong, handsome figure of a man at twenty-four.

Five years had elapsed by the time Watson again touched foot to American soil. His head, like his notebooks, was crammed with ideas for improving agriculture. He hastened to Mount Vernon, where he and George Washington spent many hours drumming upon their favorite themes: agriculture and canals.

"We are not farming the soil, we are mining the soil," Watson repeated over and over again, and he drove home that point to farmers for the rest of his life. He likewise drove home Washington's statement: "The multiplication of useful animals is a common blessing to mankind." Educational exhibits, Watson insisted, aided both causes.

Before finally settling down in Albany, New York, Watson had operated successfully his own plantation on the Chowan River near Edenton, North Carolina. It was on his way north that he had met and married Rachel Smith at Norton, Massachusetts. He had passed his thirty-first birthday and was now ready to build a home and a family.

Albany soon hummed with the multiple activities of this versatile man. He fought for good roads, free education, lower freight rates for farm products. When he failed to get financial backing for a canal connecting the Hudson River with Lake Erie, he founded the Bank of Albany, first in the city. Charters later were obtained for two canal companies, and freight costs between some points dropped an extreme 70 per cent. Watson then promoted the first stage line between Albany and Schenectady.

Almost every move he made was in the interest of agriculture. Perhaps he was over-zealous, for his conservative Dutch bank directors split with him. Forthwith he hastened to the state legis-

lature and won a short term charter for his New York State Bank. When this limited charter expired, he obtained extension by the now slightly shocking method of passing out stock certificates to the right boys in the state assembly.

In any event, this new bank of his was so successful that in four years he was able to retire, at the age of forty-nine. He did not turn to politics, where he would have excelled and where he certainly would have become a statesman, for he had the respect, warm friendship, and guidance of John Adams, second president of the United States, and of most other public leaders of his day. He likewise had exceptional intellect.

Instead he turned his substantial fortune and the full force of his amazing energy to agriculture. He wanted to teach men to farm, to stop their abusive treatment of the soil, and to give it the tender care exercised by Europeans.

It was then that he moved his wife, three sons, and two daughters to the big farm near Pittsfield, and began bringing in fine sheep, young bulls of celebrated English stock, and other animals; he tested short-legged pigs, known as the grass-fed breed, and demonstrated their progress to farmers.

Lavishly he spent his money carrying education to the farmer, sometimes by publishing and distributing latest findings, but more often by the graphic method of the fair or cattle show. Of that first show he wrote many years later: "... from that moment to the present hour, these shows, with all their connections, have predominated in my mind, greatly to the prejudice of my private affairs."

Indeed his fortune shrank. But what of it? Hadn't the Englishman, Arthur Schofield, with his carding mill on Long Island, started making his machines at Pittsfield, and wasn't Berkshire County becoming the "cradle of the woolen industry in America"? Merino wool brought only $1 a pound in 1807, and twice that much seven years later.

Watson was an astonishing enthusiast on the future of agriculture and America. In his innumerable talks to farmers—and he was the most sought-after farm speaker in the land—he painted what seemed a fantastic picture of the nation's growth. From census figures of 1790, 1800, and 1810, he projected future population totals for each succeeding decade. Even today, with each

new census return, his estimates are compared and marveled at by professionals. For example: his 1930 estimate was for a national population of 133,000,000. It was but ten million too high.

Across his dinner table, he used to argue population growth with his friends Aaron Burr and Alexander Hamilton, long before their 1804 duel in which Hamilton died. Because the great Talleyrand and other French exiles were less enthusiastic on America's future than he, his home finally was closed to them.

He pleaded with Thomas Jefferson and James Madison for the creation of a National Board of Agriculture—he was years ahead of his time. But a young fellow named Henry L. Ellsworth drank in his words and later became father of the Department of Agriculture.

James Watt, his English friend, had interested him in steam locomotion, and so he carried on voluminous correspondence with Robert Fulton and fought for a railroad connecting Boston with upper New York.

What lawmakers would not do, he did with his own money; circulars went from his office to American consuls across the globe urging them to send home new seeds, animals, and farm implements. Inspectors went into the July grain fields "to examine and award premiums to farmers entered into competition." He had preachers throughout New England praising the farm fairs from their pulpits and offering up prayers for continued success. Choirs sang special harvest odes.

Upon all these varied agricultural activities Elkanah Watson dissipated his fortune. "And to what better purpose?" he would ask. At length he disposed of his farm, returned to Albany, where he regained moderate financial security, and then acquired land on Lake Champlain, where he was instrumental in founding the town of Port Kent.

Here on his farm, a sort of "pattern farm," he carried forward his work in behalf of better farming and bigger and better "educational fairs of competition and enlightenment." Here he was host to the great—William H. Seward, Henry Clay, and Presidents Van Buren and Harrison.

And here, too, amid his rural dynasty, Elkanah Watson died December 5, 1842, shortly before his eighty-fifth birthday. A simple obelisk rises over the grave of the father of state fairs.

ELI WHITNEY

Born in Westboro, Massachusetts, December 8, 1765.
Graduated from Yale University, 1791.
Invented cotton gin, 1793.
Awarded patent, May 14, 1794.
Revolutionized gunmaking, 1798.
Congress refused patent renewal, 1812.
Married Henrietta Edwards, 1817.
Died January 8, 1825.

THE MAGNIFICENT OLD SOUTH, THE ROMANTIC story-book land of cotton, with its broad plantations and pillared mansions—that was the land which Eli Whitney helped to create. He did it by the invention of a cotton gin, a machine that changed the economic and political destiny of the South and, some claim, almost won the War of the States for Dixie.

In the entire history of agriculture there are few events as dramatic and colorful as the rise of the Old South, with its charm and chivalry, its gallant horsemen, its "darkies" singing in the moonlight.

Long before Whitney's magic wand had touched the southern fields into square miles of the fleecy staple, the cotton plant was hoary with age. Records show that cotton was grown in India 800 years before the birth of Christ. In dim and distant times Peru, across the world from India, likewise grew cotton. Both nations had created cotton textiles of extraordinary technique and pattern many years before contact had been made with the peoples of Europe.

In the Middle Ages, Indian cotton goods constituted a large part of the trade with the Far East over a long and tedious ocean trail. The thought of shortening that far-flung circuit fired men's minds; it was, indeed, to find a direct route to India that Columbus braved the Atlantic.

Six years after Columbus had discovered the West Indies, Vasco da Gama, the Portuguese shipmaster, guided his sails around the Cape of Good Hope and opened up a direct trade

route to India. Soon the new commercial sea lane was flecked with white sails, and the flow to Europe of "Calicut" cloth—which became calico—was substantially increased.

Yet for a long period it was only the rich who could afford this gay raiment, and as late as 1751 calico was sufficiently valuable for the frugal Benjamin Franklin to advertise for a dress stolen from his wife, "... a dress of printed cotton... very remarkable, the ground dark, with large red roses, and other large and yellow flowers... with many green leaves."

In the eighteenth century the lovely fabric creations of the Orient began to be duplicated in Britain and middle Europe, and the number of cloth printing mills spread rapidly, causing consternation among wool manufacturers and growers, who sought English laws that would banish cotton.

But cotton manufacture went on, mostly in homes, and when mechanical evolution threatened this cottage handicraft, mobs broke into buildings and wrecked machines. Still the tide rolled forward.

Factories in England hungered for greater cotton supplies for the production of fabrics and the British turned hopefully to the mild climate of this country. But the climate, for the most part, was not mild enough to grow the long-staple varieties of Peru and other Spanish colonies; Virginia and the Carolinas could produce only a short staple which clung so stubbornly to the seeds that India's roller gin and Peru's simple hand-separating method were useless.

Cotton must be had regardless of obstacles; so the first governor of South Carolina accepted cotton as rental on proprietary lands at seven cents a pound, thus inducing small patch planting by most settlers, who spent their winter evenings separating the fleece from the seed in the flickering light of candles. This was slow, tiring work. On larger producing tracts, where slaves were used, the Negro who could produce "a shoeful" of cotton lint in an evening was deemed a superior worker.

Under such handicaps it is surprising that cotton gained even a shaky foothold in North America and that in 1790 a total of 3,138 bales could be raised and 375 exported. World-wide demand kept increasing and the South was crying out for inventive

genius when Eli Whitney appeared on the scene and raised the lowly cotton plant to king of southern agriculture.

This New England Yankee had never seen raw cotton until he was a grown man. A farm boy, the son of Eli and Eliza Fay Whitney, he was born at Westboro, Massachusetts, December 8, 1765, more than a century and a quarter after John Whitney had emigrated from England.

At ten he surreptitiously took his father's prized watch apart and put it together again with minute precision. At twelve he made a violin and then built up a tidy violin-repairing business. Two years later he had a profitable miniature factory where, with two helpers, he made nails. After the Revolutionary War, when demand for nails ended, he turned his enterprise to knife blades and hatpins.

He put off college, mostly for lack of funds, until he was twenty-three, when his father pulled him away from farm work and invention and sent him off to Yale with a thousand dollars. Eli supplemented this by repair work on laboratory and other equipment which astonished his instructors and made unnecessary the sending of such equipment to England for repair.

When he graduated three years later and started south to accept a tutoring post, and meantime study law, he was a big, tall, pleasant fellow of dignified bearing, of original mind, and of immense perseverance.

On the boat to Savannah, Georgia, Whitney met another Yale graduate, Phineas Miller, who was manager of Mulberry Grove, near Savannah, the plantation of the late famous Revolutionary War general, Nathanael Greene. Miller introduced Whitney to the widow and family of General Greene, who were on the homeward voyage after having spent the summer in the North.

When Whitney arrived at his post he was shocked to learn that financial reverses had struck his intended employer. The contemplated job had vanished. Almost penniless, he was taken in as a guest by Mrs. Greene. He began studying law and working about the plantation, where he put to excellent use his exceptional inventive genius.

One winter evening a group of gentlemen guests were deploring the state of agriculture. Along the coast some long-staple

cotton was being grown and seeded by machine, but the South's hope of greatness—of large cotton exports—rested on creation of a machine that could separate seeds from short-staple cotton.

"Why not talk to young Mr. Whitney?" asked Mrs. Greene, who later became the wife of Miller. "He can make anything."

They did. Whitney was interested. He closeted himself and in ten days created the principle of the cotton gin still in use today. Its spikes (or saws) operate through slotted apertures and pull the fibers from the seeds; brushes remove the fibers from the spikes.

By April of 1793 Whitney had built a larger machine with which a Negro could produce fifty pounds of cleaned cotton in a day. He felt his job was completed and returned to the study of law. But Phineas Miller induced him to seek a patent and manufacture machines. They entered into a partnership May 27, 1793, which continued for ten years, until Miller died, poor and heart-broken by the desperate struggle to protect their rights.

News of the new machine had spread like wildfire. Crowds kept coming to see with their own eyes; designs were stolen and imitations began appearing even before Whitney could obtain his patent. Through the sympathetic assistance of Thomas Jefferson, Secretary of State, then in charge of patent grants, he was awarded a patent on May 14, 1794.

Back in New Haven, Whitney began manufacturing machines and shipping them to Miller. Obstacles multiplied: competition from infringers forced them to pay interest rates of up to 25 per cent; false stories were circulated in England to the effect that their machine injured cotton, and these canards bogged down their progress. Fire destroyed their factory in 1795; legislatures intending to buy patent rights suddenly annulled contracts.

Not until 1807 did Whitney, after endless court fights, obtain a favorable decision against infringement. But the decision came too late and was an empty victory. Five years later, with singular ingratitude, Congress refused application for a patent renewal despite preponderant evidence of justification.

So Whitney, one of the great men of American agricultural and economic history, received practically no return for his tremendous invention.

Yet there is no instance in the record of invention where industrial forces were launched with such immense impact.

In 1792, the year before invention of the gin (a lazy way of saying engine), cotton exports were 138,328 pounds; in 1794 exports were 1,601,000 pounds, the next year 6,276,000 pounds, and five years later, nearly three times that total.

Upon the entire South the effects of the cotton gin were striking. Before its advent, George Washington's gospel of diversified farming had been gaining followers. Lands west of the Blue Ridge and the Alleghenies were being occupied by small farmers who were forced by necessity to grow food and feed crops as well as crops for cash sale. Protests to New England were even being made by Southerners against importation of more slaves from Africa.

With amazing suddenness the gin reversed the tide. It was revolutionary to agriculture. The entire South turned to cotton. New lands were opened; the Carolinas switched from rice to cotton; Tennessee farmers reconverted immediately; the new states down the great river were taken over by cotton planters. Cities grew rich as the magnificent South of broad plantations took over, and, far from decrying slavery, the cotton-growing South, now firmly intrenched as the world's great producing area, shouted for more and more slaves. Mills in Europe hummed as the white staple spread over wider and wider areas.

Cotton was king—king for the first five decades of the nineteenth century—with fortunes rolling in to the planters, who were comparatively small in number but strong politically, ready to dare anything, even secession, which they did dare in 1860. They believed secession would be peaceful, that the plantation civilization would be perpetuated, that European countries depending on American cotton would give any needed assistance in an armed conflict.

There are those in the cotton world who believe the South might have won the war save for one colossal mistake: the bumper crop of 1859 was exported before hostilities broke out. This gave England and France a large backlog which kept their mills going for some time. By the time such backlog was exhausted, causing great unemployment, the Federal navy had blockaded Southern

HENRY L. ELLSWORTH

Soldier of the Land

HENRY L. ELLSWORTH

Born in Windsor, Connecticut, November 10, 1791.
Graduated from Yale University, 1810.
Passed Connecticut Bar, 1813.
Married Nancy Goodrich, 1813.
President Aetna Insurance Company, 1819-21.
Resettled Indians beyond Mississippi River, 1832.
Head of U. S. Patent Office, 1835-45.
Won first congressional appropriation for agriculture, 1839.
Moved to Lafayette, Indiana, 1845.
Died in Connecticut, December 27, 1858.

TWO WEARY HORSEMEN DREW TO A HALT ON THE tip of a rise. Below them the virgin prairie stretched off to the distant horizon. Pointing excitedly, one rider exclaimed:

"You can see what I mean. These flat rich lands, clear of forest and stone, can become a vast and bounteous garden."

The speaker was Henry Ellsworth, a man whose lofty dreams were studded with logic and backed by dynamic energy. History rightly calls him the father of our United States Department of Agriculture.

His companion, Washington Irving, stared long at the sprawling landscape tinted by a low-hanging sun. Then he murmured, "It is truly breath-taking, Henry. What a thrill it is to be an American."

That night the riders, too excited to sleep, lay long beside a glowing campfire looking up into a velvet sky sparkling with stars. "These prairies," said Ellsworth, "could feed all mankind."

At sun-up next day they were off to rejoin other riders. When the arduous trek of the midwest prairie lands was at last completed, they returned east, Ellsworth to Washington, and Irving to his home, where he wrote, and in 1835 published, *A Tour on the Prairies.* In the minds of eastern farmers this book, and the reports of Ellsworth, kindled new thoughts of adventure. They lengthened the lines of white-topped prairie schooners that crawled westward to break sod and build villages and towns and cities and to make America first in the production of food.

Henry Leavitt Ellsworth loved the land with a deep and consuming fervor. Yet he was no log cabin boy, scratching the soil for a living and reading books by candle light. On the contrary he came of an illustrious family, first of whom reached Connecticut from England around 1640.

His father, Oliver Ellsworth, entered Yale at seventeen and later transferred to Princeton, where his companions included Aaron Burr, James Madison, and Henry Lee of Virginia. He married the wise and lovely Abigail Wolcott, whose uncle signed the Declaration of Independence for Connecticut. He worked on military finances with George Washington during the siege of Boston, rose to national stature, and became Chief Justice of the United States. Four years later he resigned to lead a mission for negotiating with France's newly-risen Bonaparte and the crafty Talleyrand. Wealthy and distinguished, this father of Henry Ellsworth died at fifty-six.

On the spacious farm at Windsor, Connecticut, which the elder Ellsworth had cleared of forest as a bridegroom, Henry Ellsworth and his twin brother William were born November 10, 1791.

"We were inspired by our parents," wrote Henry late in life, "to strive to do something for our country, for the land."

The twin brothers attended Yale and Litchfield Law School. William married Noah Webster's daughter, served five years in Congress, four terms as Connecticut's governor, and then sat on the state supreme court until his death at seventy-seven.

But Henry Ellsworth was enamored of the land. He married Nancy, daughter of Elizur Goodrich, and plunged at once into farm activities, running the county agricultural society and other non-profit farm projects for a decade. For income he practiced law, at which he excelled, and served two years as president of Aetna Insurance Company.

His brilliant work with farmers had caught the attention of President Andrew Jackson. So in 1832 he was commissioned by Jackson to help resettle displaced Indian tribes on new hunting grounds beyond the Mississippi. It was on this first mission that his eyes and the eyes of Washington Irving were opened to the immensity of America's potential farm garden. Wrote Irving: "We... rode through deep rich bottoms of alluvial soil, overgrown with redundant vegetation...."

He describes the tall, straight Ellsworth as a Christian man "in whom a course of legal practice and political life had not been able to vitiate an innate simplicity of heart," and lauds his genius for promoting peace among the warlike tribes.

For precise detail of this historical adventure Ellsworth's own 116-page letter to his wife, now in the library of Yale University, shines out over the work of the famous author.

A vision of eastern farmers, bent and weary with carrying off rocks and digging out stumps, tortured Ellsworth after the journey into the rich plains. He became eager and subtly combative. Only his "better judgment" restrained him from crying out against the blindness and stupidity of political leaders toward farmer needs.

He determined to move lightly, to lead instead of drive. A close reading of the records indicates that his every act from the day he entered the Patents Office in 1835 was aimed at the single objective: government recognition of agriculture. In the end he won out.

The patents office was a mess. Originally directed by a three-man cabinet commission, including Thomas Jefferson, it had for two decades rocked along lazily under loose supervision. Ellsworth saw that a new patent law with teeth was needed quickly. He pushed the act through Congress on the sixtieth anniversary of the Declaration of Independence and its basic concepts continue today.

At once he was named Commissioner of Patents, worked like a beaver restoring order, and then quietly began screening and pushing ahead patents on plows and other farm equipment. His deep soft eyes, under black brows, kindled when he confided ambitious plans to close friends.

Then misfortune struck. Fire destroyed the Blodgett Hotel, housing his offices. For a full year he struggled night and day restoring two thousand lost patents.

Once again his path was cleared, and his letters and talks breathed—and sometimes shouted—the needs of agriculture. Critics began to grumble. They noted that his reports to Congress were over-packed with agricultural propaganda. He ignored legal authority and used his patent office to receive and distribute seeds and plants. A few friendly congressmen provided mailing

franks. His audacity made Congress blink in wonder when he proposed "a regular system" of distributing choice grains and seeds, and also a display of them in the patent office.

In 1839 he shattered the first barrier when he slipped into the patents office appropriation bill a Section 9, which set aside a thousand dollars "to be expended in collection of agricultural statistics, and for . . . other purposes." The tall man with the side-whiskers, high collar, and broad black tie, was jubilant as he watched the bill slide through.

Still he faced the fear of adverse press reaction. But the papers next day screamed only of threatened war with Britain over the Maine–New Brunswick border dispute. They reported warlike speeches by Representatives Saltonstall and Adams and by Senators Daniel Webster, Clay, and Calhoun, and the thunderous warnings of the Duke of Wellington from across the sea. But not a line was there on the historical Ellsworth appropriation, which did in fact mark the inception of the Department of Agriculture. Ellsworth smiled and wrote another confidential note to his farmer friends up north: "We must push our good fortune."

Lady Luck was flighty and the next two years were empty of appropriations. Mysteriously, however, Ellsworth seemed to have funds for farm activities and drove steadily ahead with his program, now preaching mechanized farming for the prairie states, now demanding free lectures for farm boys.

"Sons of farmers, after years of toil at the plow, should be able to attend lectures at the seat of government" and acquire knowledge of chemistry and apply it to the soil.

Sterner words sharpened his 1843 report. He implied the greater importance of agriculture over patents, and hinted at the growing influence of the farmer. Merely distributing thirty or forty thousand seed packages a year and gathering statistics were not enough.

"If millions can be saved . . . if the agriculturalist can be encouraged . . . by expenditure of a small sum from the annual patent fund surplus, what better destination . . ."

Congress began to crack under the fire of Ellsworth's determination. Members were impressed, too, by his statistical report covering twenty-nine states, giving population figures as well as production reports on sixteen leading commodities. The New

York *Herald-Tribune* published his report as "No. 2 of Useful Books for the People" and sold it widely at 25 cents. Support for his cause ballooned, and congressmen began hearing from constituents. Ellsworth delegated duties to assistants and expanded activities. The "small sum from the patent fund surplus" apparently stretched further than the members of Congress had suspected.

Ellsworth now instilled life and action into the Agricultural Society of the United States, formed to exchange facts with farm groups across the land. It sought an agricultural school for Washington, an experimental farm, and exhibitions at fairs. Farmer interest rose to a new pitch.

Meantime duties multiplied in the patents end. A Yale classmate and close friend was a man named Samuel F. B. Morse. He had a patent for an Electro-Magnetic Telegraph. Ellsworth helped foster a bill for $30,000 for testing the "mad inventor's contraption." Together they sat in the congressional gallery on the night of February 23, 1843. By eight votes the House had approved. But abuse in the Senate was such that the crestfallen Morse left at midnight. Ellsworth stayed on.

Next morning Morse was prepared to leave for home with his rail ticket and 37 cents when Ellsworth's daughter Annie arrived breathless to say the bill had passed. As reward for bearing good news it was Annie who handed Morse the first message to stutter over telegraph wires on May 24, 1844. It read simply: "What hath God wrought?"

Three weeks later Ellsworth granted a patent to Charles Goodyear for making vulcanized India rubber.

The Morse and Goodyear patents, and especially the invaluable farm statistics, had fascinated former President John Quincy Adams. He set down his thoughts in his memoirs on March 31, 1845.

"I became immersed this morning," he wrote, "in the annual report of the Commissioner—a document rendered so interesting that the House ordered twenty-five thousand copies printed for circulation by members. He has for a succession of years been improving it, till it forms a five hundred page volume, and a calendar of mechanical and agricultural inventions more sought after than any other annual document published by Congress. He

has turned the patent office from a mere gim-crack shop into a great and highly useful public establishment."

But Ellsworth was tiring under the strain of monumental duties. His hair and side-whiskers were turning gray. Overwork had tightened the mouth line, with its downturned corners. He yearned now to be a part of that land which he had been purchasing from the time of his first trek across the plains. Nine years previously his son Henry, soon after graduation from Yale, had gone west to manage these lands. He had written various tracts on ditching and fencing and published several books on swine raising.

So when President Polk appointed young Ellsworth chargé d'affaires to Sweden and Norway, the Patents Commissioner resigned his office and settled at Lafayette, Indiana, five miles down the Wabash River from the spot where William Henry Harrison defeated the Indians under Tecumseh at the battle of Tippecanoe.

Still eager and restive, he rode horses over his beloved plains, fired farmers into new enthusiasm, introduced equipment, and was credited with using the first mowing machine. He had a few golden years close to the soil where he could see some of the fruits of his long struggle to expand and improve agriculture. Then his wife died in 1847. Later he married Marietta Bartlett of Guilford, Connecticut, who also died, in 1856.

Broken in health, he returned to Connecticut the next year and died at the age of sixty-seven, four years before formal establishment of our now immense Federal Department of Agriculture which had some ninety thousand workers at the peak of World War II. A third wife, Catherine Smith, survived.

Henry Ellsworth died knowing a long and noble battle had been won. Even cynics who had embraced the bleak philosophy that the prairies were too far from the forests to be of use grudgingly praised his devotion to a cause, while farmers mourned the loss of their battle leader whom they termed a soldier of the land.

To the end, against all odds, Henry Ellsworth had clung determinedly to the idea of mechanized farming—cultivation of the prairies by steam plow and machinery. Strangely enough, these ideas of his were used by contestants of the will in an attempt to prove mental unsoundness when he left his residuary estate to Yale University.

EDMUND RUFFIN

Father of Soil Chemistry

EDMUND RUFFIN

Born in Prince George County, Virginia, January 5, 1794.

Attended College of William and Mary, 1810-12.

Served in War of 1812.

Married Susan Travis of Williamsburg, 1813.

Began soil experiments, 1813.

Elected to Virginia Senate, 1824.

Published and edited "Farmers' Register," 1833-42.

Published "Observations on the Abuses of the Banking System," 1841.

Agricultural surveyor for South Carolina, 1842-43.

First president Virginia State Agricultural Society, 1844.

Fired first shot of Civil War on April 12, 1861.

Died in Amelia County, June 18, 1865.

IT HAD BEEN A LONG NIGHT FOR THE FRAIL OLD man with the fierce eyes. He had slept but fitfully in his rumpled suit of homespun, determined that no trick of fate should rob him of a promised honor he prized beyond life itself.

At length a ruffle of drums cut through the heavy silence. He rose from his army cot, clapped on his black hat with its cockade of the secessionist, and marched briskly with the guard to his post beside a sixty-four-pound cannon.

There in the false dawn, his long snow-white locks cascading down his shoulders, he drew a careful bead on Fort Sumter, etched in ghostly shadow against a wall of eastern sky. At a given signal he pulled the lanyard of the Columbiad. The historic shell arched slow and high over the dark waters of the bay and burst at the northeast angle of the parapet.

That single shot of April 12, 1861, set in motion the grim and tragic war between North and South. In firing the first shell for Southern independence, Edmund Ruffin, father of soil chemistry in America, had brought to a dramatic climax his long and bitter fight for secession.

Slumbering Charleston was aroused by the thunder of the shell; it marked the birth of a new and ill-fated nation, and the death of the Old South. It also marked the beginning of the end for Edmund Ruffin, who loved the Old South with a limitless passion.

A gentleman farmer of Virginia, Ruffin had in effect lived two lives—the life of a truly great agriculturist, and the life of an

uncompromising secessionist whose flaming words burned deep into the hearts of men. As an agriculturist, he was a precisionist, a man of cold scientific exactitude; as a fiery crusader his furious emotions stirred men to deeds beyond human endurance. In both he was guided by noble instincts, touched with a deep religious fervor. His spirit shall forever march the Southern fields.

For a hundred and twenty-eight years the Ruffins had lived in this country before the birth on January 5, 1794, of Edmund Ruffin, fifth in America to bear the name. William Ruffin had "seated" in Isle of Wight County, Virginia, in 1666, and had prospered in a region where broad acres and Negro slaves gave position and power, and where intermarriage tied proud families into ruling cliques.

Acres widened from one generation to the next, and the estate of Edmund's father George at Coggin's Point in Prince George County once ranked with other great plantations of the Tidewater region.

Edmund's mother, Jane Lucas, was a somewhat shadowy figure who died young; the rearing of her only child was left to a stepmother, Rebecca Cocke. He was a frail lad of restless spirit, a tireless reader who had finished Shakespeare's plays before he was ten, and by fifteen had absorbed most of the classics.

Why a youth of such brilliant and penetrating mind should have met scholastic failure at the College of William and Mary is not made clear in his comprehensive journals. It appears he simply was not interested. His father had died in 1810 and his thoughts concerned plantation management. He served six months in the War of 1812 before settling down on his Tidewater inheritance. At about the same time he married Susan Travis of a prominent Williamsburg family, who bore him eleven children.

In the colonial history of the Old Dominion the story of agriculture's struggle is traced in sharp outline. Tobacco growing had brought a solid prosperity to planters. But tobacco's depletion of the soil was shocking. New land was planted to tobacco for a few years, then to Indian corn; then the tattered, impoverished acres were abandoned to deer and wild fowl and new fields sought. In the older regions the harmful system had run its course, well before the American Revolution; only a few great planters such as Washington and Jefferson had fought for soil conservation.

So two centuries of destructive methods faced young Edmund Ruffin when he took over the tired land of his forebears. Before long he was watching downcast planters move their puny livestock and ragged slaves westward, and he was hearing them declare that an angel of desolation had cursed the land. The plight was soon recorded in the downward slide of population growth in Virginia. Conditions were no better in Maryland and the Carolinas.

Vowing he would never join the cavalcade of the defeated, the youth began an intensive campaign to improve his land. Neighbors sneered or chuckled as he adopted—one after another—all the latest known methods of soil improvement and crop rotation, including those of the respected John Taylor; but strive as he might, bitter failure dogged his tracks for several years.

Low in spirit and fearful of his future responsibility to family and slaves, he was in his library one rainy day studying a newly-acquired book titled *Agricultural Chemistry,* by Sir Humphrey Davy. As he turned the pages his attention was suddenly arrested and his hope rekindled by the words:

"... sterile soils containing... the salt of iron, or any acid matter... may be ameliorated by the application of quick-lime."

Here was something to ponder.

To Ruffin it was a startling thought. He wondered whether the curse of the Virginia planter possibly could be traced to such a soil condition. Even though he was ignorant of chemical science, he would find out for himself. At once he set about making a clumsy test. Gradually the analysis was refined and perfected. And in the end it failed to reveal any mineral acids.

But wait. Ruffin recalled that he had long observed the presence of sorrel and pine on the poorer lands. This factor must be studied. It was, and very thoroughly, too; and at length he reached a conclusion, an original one: vegetable acids, as he termed them, were definitely present, and such acids were the cause of sterile soil. This condition, he further concluded, could be corrected by the addition of marl, or common fossil shells so abundant in the vicinity. His new theory was that most lands were basically fertile —that the factor of acidity must be removed.

Negroes were set to work digging pits on his lower lands one winter morning in 1818. From these pits they carted two hundred

bushels of marl and spread it evenly over a stretch of poor, newly-cleared land, which was later planted to corn.

With mingled hope and dread the young experimenter awaited the verdict of his test field. In a few weeks it came, and a wave of joy swept the plantation; even the slaves joined in the rejoicing. For the marled field had told a story, a story clear and indisputable, in strong young blades from which, at harvest time, production was increased by 40 per cent.

It was a surprising revelation, an amazing discovery for that age. A new era in agricultural history had dawned.

Back to the pits went the Negroes and the carts, and back to his chemical tests went Ruffin, burning with new faith and hope. He paused after harvest to present to his county agricultural society a cautiously worded paper on his findings, avoiding any claim to a revolutionary approach; indeed, he himself was none too certain that the discovery could check the stream of farmers who were deserting their lands, and possibly save the Old South. But some hope was lighted in the minds of others by his paper that autumn, the first paper, incidentally, of an almost continuous stream, for few men had a livelier pen than this Ruffin, who noted in his journal, "I can, with pleasure, write rapidly for twelve or more hours in the day or night. . . ." His output was in fact prodigious.

Briefly stated, Ruffin's new gospel was this: Naturally poor soils differed substantially in their power of retaining putrescent manures from those soils naturally rich but reduced by cultivation. Capacity for soil improvement was in direct proportion to the degree of natural fertility. Such fertility depended upon the presence of a proper amount of calcareous earth, which neutralized vegetable acids and gave power of combination with manures for productivity.

In the soils of lower Virginia this element was lacking. Hence it was idle to seek land enrichment by use of animal and vegetable fertilizers, as all were doing, until ample marl had been added to correct the defect in their constitution. After such correction, by addition of marl, the refinements of good farming would bring "more productiveness and more profits" than men had dreamed possible.

This initial step in the adoption of soil chemistry in the South

was followed by crop rotation, the building of covered drains, better plowing, production of clover and cow peas, and better use of slave labor. In the new pageant of agricultural progress Ruffin, with boldness and determination, led the way.

Enlarged, but factually unaltered, Ruffin's first paper was published three years later by John Skinner's *American Farmer*, which hailed it as "the first attempt... to examine into the real composition of the soils." Eleven years later it appeared as a volume of 242 pages under the title, *An Essay on Calcareous Manures*, ran through five editions, and at the turn of the present century was called by government experts the most thorough work on a special agricultural subject ever published in the English language. President John Tyler spoke the public's mind when he declared that the Essay was worth more to the country than all the celebrated state papers of the time. Then he hung Ruffin's portrait over his mantel beside that of Daniel Webster.

Scientist Ruffin carried on his battle in an age when farm tradition was against the scientist and the theorist. He spread his gospel for three years in the Virginia legislature, to which he was elected when he was thirty. As first president of the Virginia state agricultural society he pounded away at the dissenters. Later he viewed the fruits of his efforts in South Carolina, where he served as a special surveyor of agriculture.

To give greater drive to the agricultural revolution he launched the *Farmers' Register* at Petersburg in 1833, a sixty-four-page monthly of solid reading matter, half of which he wrote himself, and which proved a mighty force in the rebirth of the South. It became a power, the bible of the agrarian, "the best ever published in this country or Europe," in the words of Skinner, himself a brilliant authority. Even today experts rate its editorial quality as equal to the best in any period.

In the ten-year life of the *Register* the rise of agriculture was astonishing. Fleeing emigrants turned back homeward to find stricken fields transformed into stretches of luxuriant corn. Verdant acres of abundant harvests had replaced "broomstraw and poverty grass"; the thin, stunted vegetables had disappeared. Land values were rising. Farmers returned thanks "to the Divine Providence and our native son."

But in all this rejoicing Ruffin was desperately unhappy. He

had determined to keep the *Register* free of advertising and abstain from politics. But how could he remain silent in the face of the inroads "of the Yankees, their destructive tariff," and the rotten banking system? In a white-hot anger he cut loose with a flow of invectives that shocked conservative Virginia; he launched a second publication, the *Bank Reformer,* and charged plundering, fraud, tyranny.

Strangely, here was a Federalist, a gentleman planter who detested Jefferson's faith in rule by the masses, and would prefer instead a limited monarchy, now fighting for the rights of the little man. Powerful conservative interests beat him down, and in time forced him to close both publications.

Even his neighbors, the sensitive Ruffin felt, were in this period weak-kneed and lacking in loyalty; so in humiliation and disgust he moved his home to Hanover County on the Pamunkey, and, with a magic touch which many regarded as little short of witchery, turned wretched stretches into a fertile garden, making beautiful "Marlbourne" a "seating" that befitted any gentleman.

Virginia was not miserly in its honors to Ruffin. It simply could not embrace his views on secession, which were becoming more and more extreme. Only in South Carolina, where his heroic deeds on the land and in politics placed him on a pinnacle, could he find kindred spirits, men ready to die to defend states' rights; men, with emotion on their side, who believed implicity in the justice of their cause.

So as the clouds of war thickened, Ruffin spent much time in South Carolina, and spoke frequently in other friendly states, his steel-grey eyes, deep-set under heavy brows, searching the faces of men for courage or cowardice, and stirring them to a frenzy.

He finally had given up personal direction of his estate and had set to work with pen and voice defending slavery, revealing Northern duplicity and urging the birth of a Southern nation. He looked on at the execution of John Brown after the latter's abortive attempt to inspire an uprising of slaves by his attack on Harper's Ferry; in his diary he denounced the "villain" and then praised his calm, fearless inspection of the gallows and his admirable unconcern when the rope was adjusted. In Brown he saw another man with an eternal faith in a cause.

Lincoln's election was a major blow.

Ruffin hastened back to South Carolina, and everywhere the fiery little Virginian was greeted with wild acclaim by secessionists. At the peak of his glory he joined the South Carolina Minute Men, and had the cockade stitched to his hat. As state after state followed South Carolina into secession, Ruffin's immense popularity grew. The choice of this man, "67 years young," to fire the first shot of the war was never in doubt.

Later we see him buying a barrel of crackers and a head of cheese and joining the battle of Bull Run; digging trenches, marching till he fell in his tracks, then clinging with set teeth to the seat of a jogging caisson. We see him again firing a first shot, this time at a ragged, broken line of blue rushing back pellmell toward Centerville; and later we see him riding out on the field to count his dead.

Even when the tide finally turned, when defeat after defeat sealed the fate of the Old South, Edmund Ruffin's great heart fought on. His properties rifled and destroyed, his huge library torn to tatters, he began giving his remaining funds to the tottering Confederacy.

It was only after Lee's once glorious army had laid down its arms to the men in blue that Ruffin, now sheltered in his son's home in Amelia County, visualized a horrible future for the South—"oppression, insult, outrage."

From his diary:

"I here declare my unmitigated hatred of Yankee rule.... I cannot survive the loss of the liberties of my country...."

He had kept much to his chamber of late, filling his diary, and penning letters of instruction to his family.

Suddenly on this quiet Sunday morning another shot rang out.

From the *Daily National Intelligencer*, Washington, D. C., June 22, 1865:

"... Mr. Ruffin bathed himself, put on clean clothing... seated himself in a chair, put a loaded musket to his mouth, and, leaning back, struck the trigger with a hickory stick...."

JOHN DEERE

He Turned the Prairies

JOHN DEERE

Born in Rutland, Vermont, February 7, 1804.
Apprenticed to a blacksmith in 1819.
Moved to Grand Detour, Illinois, in 1836.
Invented steel plow in 1837.
Built plow factory in 1846.
Moved factory to Moline in 1847.
Died May 17, 1886.

MYSTERY AND TRAGEDY TOUCHED THE LIFE OF John Deere when he was still an infant. He was born on February 7, 1804, in the village of Rutland, Vermont. His father, William, a British-born merchant tailor, shortly moved his shop and scant chattels to near-by Middlebury, up the valley of Otter Creek.

In the following June, for some reason not quite clear, the elder Deere was compelled to go abroad. From the port of embarkation he wrote a letter to his eldest son, apprenticed to a merchant, urging him to be dutiful to his mother, faithful to his master and true to his God. He alluded to the fact that a cousin, supposedly lost at sea, had suddenly shown up.

"Consequently," he wrote, "it will make a great alteration in my affairs, but I hope to obtain the means of paying my debts and making our family comfortable.... I am in expectation of embarking for England on the first fair wind."

The fair wind came and ballooned the ship's canvas; anchor was lifted and William Deere sailed away and out of the lives of his family forever. His trunk arrived in England; no trace of him ever was found. He simply vanished.

John's mother, Sarah Yates Deere, was the daughter of a British soldier who had fought in the Revolution but had remained to make America his home. She was of sterling character and high courage.

In the tragic situation, with four children, John a babe in arms, her decision was prompt and firm. She herself would continue

running the tailor shop and thus hold her little brood together. Her devoted husband, she was sure, would sometime return; perhaps he had been washed overboard by a gale and had reached an island, where one day a ship would poke its nose out of the fog and pick him up. And while she slaved and saved, Sarah Deere went on dreaming her dream for twenty-two years; and then she died.

She died more than a decade before her son John, a blacksmith, invented a plow, a shiny steel plow that miraculously turned the rich, sticky loam of the prairies. It was that plow that helped transform the mid-west into the world's foremost foodbasket. The deep clean furrow which it cut across the prairies finally ran its way around the world. The plow John Deere fashioned more than a century ago contributed substantially to the well-being of mankind, and it lifted the blacksmith to a place in history among those who helped shape our mammoth agricultural empire.

Valiant Sarah Deere was mother, father, and companion to young John in those stern New England days when making a living was not a path for tender feet. She was inspiring and kindly; she was patient and understanding, even on that occasion when at the age of eight John hitch-hiked up toward Lake Champlain for a glimpse of the War of 1812. The fearsome cannonading soon sent him scurrying back to his mother's arms.

Somehow she managed to send him through grammar school and then placed him in Middlebury Academy, one of Vermont's two institutions of higher learning. But this could not last; the strain on her face worried him, and she shortly discovered, with sinking heart, that he had obtained a job grinding bark at a local tannery. She knew his days of study were over.

He had determined to work and add what little he could to the family budget and try to erase the haunted look in his mother's eyes. He could add little, however, even after he had apprenticed himself to Captain Benjamin Lawrence to learn the blacksmith trade, for his remuneration was only $30 a year and found. But he learned rapidly and at the end of the fourth year set forth on his own as a journeyman.

The blacksmith was a man of some importance in his community. In those days his was the work of forging all tools by which men lived, from household equipment to implements of

the field. For John Deere, making horseshoes and nailing them to the hoofs at 25 cents each was child's play. Soon he was hoisting oxen aloft in the clumsy ox-frame and fitting the hot iron shoes to their vicious hoofs.

But where he really excelled was in the ironwork on carriages and wagons and stagecoaches, and in the links and buckles that held harnesses and other trappings of travel firm and safe. It soon became apparent that John Deere had brought talent to an old and honored craft. He could create; whatever could be wrought in iron he could fashion to a nicety.

As he labored in the glow of the forge he would have delighted the heart of a poet. He was tall, broad-shouldered, a youthful giant, with keen, merry blue eyes, a splendid head of waving hair, and muscles like iron bands.

For ten years after his apprenticeship he worked for others or ran his own shop, moving about the state—Burlington, Vergennes, Leicester and Hancock—much of the time making shovels, hoes, pitchforks, and other tools coveted by Vermont farmers, and lasting, some of them, for half a century.

The country was restless in the 1830's. There was a stirring and straining toward a new and greater destiny. It was a feeling then hard to define. It was, in fact, a nation on the march, and the road led westward. Even the stolid, home-loving Vermont farmers felt a nagging unease; getting ahead with their severe soil and climate was a grim task. Many began joining the caravans snaking their way toward the setting sun.

This spirit was contagious and it finally caught John Deere in its grip. For several years he had listened to the fabulous golden tales from the prairies and, while making repairs and replacements, had questioned stagecoach drivers and others, always to find the basic facts the same.

His decision came after his friend Leonard Andrus had sold his store and explored Illinois for an ideal home spot. Andrus had paddled up the Rock River, skirted lush wooded islands and high bluffs, and finally had come to a tiny settlement nestling in the elbow of the stream. It was called Grand Detour.

"Here, in the peace of the prairies, I shall build a city," said Andrus, as he prepared his supper while friendly Indians looked on.

He returned to Vermont and his glowing stories of this new Eden inspired a small party to follow him out the next year, including his future father-in-law, Amos Bosworth, who owned a stagecoach enterprise and who gave much business to John Deere. That decided Deere. If Amos Bosworth, a man of such estate, could pull stakes and answer the call of the West, certainly poor John Deere had nothing to lose.

So in 1836, when he was thirty-two years old, and had been married nine years to Demarius Lamb from over east of the Middlebury Mountains, and had become the father of three daughters and one son, Blacksmith Deere kissed all a fond farewell and started off with only the tools of his trade.

He traveled by coach, by canal, and by lakes to Chicago, where he arrived with $73 and boundless courage, and then pushed onward to Grand Detour. Hardly had he set down his tool kit when he was asked to repair a broken metal shaft in a near-by sawmill. Quickly he built a forge of clay and river stones and soon the mill again was turning out boards for the homes of waiting settlers.

He never again worried over lack of trade; farmers began dumping their faulty implements on the floor of his little shop and were delighted with his skill. He dispatched money back to his family, built a little New England type cottage which, restored, still stands today, and in two years sent for his family to join him.

Plows. Plows. Plows. Bent, broken, shattered. Almost from the day of his arrival at Grand Detour John Deere had labored on plows that had been smashed up in the fertile Illinois soil. Farmers would carry them in on their backs and fling them down in anger.

In the same breath they would damn the plow and praise the rich soil. Among many there was a growing discontent, a conviction that such soil never could be plowed. A few discouraged farmers started back east, just a trickle, but the thin line widened. John Deere lay awake nights, pondering this problem.

Turning the soil had always been a major task of mankind. The first plows used in this country were little better than medieval ones. Charles Newbold produced the first cast-iron plow in America in 1796. Thomas Jefferson worked out a moldboard de-

sign, models of which have been found in Paris. Even Daniel Webster once toyed with the riddle. Jethro Wood and David Peacock were practical plow designers. The Clute and the Wiard were among early plows that served fairly well in the loose and more sandy eastern soil.

But the rich muck of the prairies clung to these plows in gobs that called for constant paddle-cleaning and sometimes two teams of oxen to do the pulling.

One indisputable fact stood out crystal clear: The prairies must have a plow that scoured, one that cleaned itself. Otherwise the dream of prairie greatness was a snare and a delusion. Such was the conclusion farmers had reached when the dream of John Deere began taking shape and form.

Months on end he had thought of nothing but a plow that would scour. Then one day in Leonard Andrus' sawmill he spied a large circular saw blade of fine Sheffield steel which had been broken and discarded. A thought flashed through his mind; he trembled with excitement. Even prairie muck could not cling to such metal. His mind instantly pictured a plowshare and gently curving moldboard, a moldboard from which the earth would fall away quickly.

So he cut the teeth from the mill-saw with a hand-chisel. He made a paper pattern for moldboard and share. With a hand-chisel and sledge the steel was cut to the pattern and then heated on the forge and shaped a bit at a time with a hammer. Upright standards were made of bar iron. The wood parts were made of saplings; the handles of crooked sapling roots. The beam was shaped out of a stick of timber with axe and drawing-knife.

There it was. There was the plow, crude, ugly, unimposing, light enough for a man to shoulder, its steel blade gleaming in the morning sun. No one, not even John Deere, dreamed of its immense future influence.

On this bright morning in 1837, when John Deere was thirty-three, he set his plow in a boat and rowed across the river where his friend Lewis Crandall was waiting in a field in which "no plow could ever scour." Other boats filled with farmers crossed the river.

As the silent group gathered about, a horse was hitched to the plow, and began pressing forward. The steel cut into the very moist ground, moving steadily, easily, without tug or jerk. The

plow bottom came through scoured and polished, made even brighter by friction of the soil. The moldboard was clean.

At the end of a long, straight row, a great shout arose from the crowd. The miracle was there—a plow that scoured itself. Excitement mounted, joyous excitement of men who knew now there was no longer fear of lack of crops. At long last the rich prairie soil could be turned, year after year and, if put to it, the great Middle West could feed the world.

John Deere turned to Crandall:

"I am giving you this first steel plow, Lewis, for use of the horse and the field. I'd like to keep it for a time as a pattern."

There was no rest for John Deere, blacksmith, master mechanic, and inventor. He had designed a plow that would turn the prairies; he must get it into use.

He built three plows the next year, and ten the next, while carrying on his regular trade. The fifth year, in 1842, he built a hundred of the "Self-Polishers," kept one always on exhibit, let farmers take them on trial and pay $10 if satisfied.

He labored on improvement until the moldboard shaping attained near-perfection. He fought for steel at reasonable rates; he loaded plows on wagons and moved them about the countryside.

A factory was built near the blacksmith shop and turned out a thousand plows in 1846, and the next year he moved his business seventy miles to the more advantageous village of Moline on the Mississippi, where for the ensuing ten years he himself spent much time at the anvil.

Years moved by, the railroad came, and the telegraph. Son Charles returned from college with exceptional business instinct and rapidly expanded distribution while John Deere continued to be absorbed in design and improvement. Each year more furrows were cut over wider areas as settlers poured into the prairie states.

He had added other farm implements to his line, but as late as 1868 John Deere announced he had discovered and applied "new and valuable features" to his plow. The plow was his first

love and so remained up to the day of his death on May 17, 1886.

They buried him on a high bluff overlooking the town and the smokestacks of his factories.

"He that invents a machine," wrote Henry Ward Beecher, "augments the power of man and the well-being of mankind."

This John Deere did in Grand Detour, still a tiny village sleeping in an elbow of the Rock River.

CYRUS HALL McCORMICK

Man with the Reaper

CYRUS HALL McCORMICK

Born in Virginia, February 15, 1809.
Attended country schools.
Invented the reaper, 1831.
Demonstrated the reaper publicly, 1832.
Established factory western New York, 1844.
Established Chicago factory, 1847.
Married Nettie Fowler, 1858.
Rebuilt Chicago factory after Chicago fire, 1871.
Died May 13, 1884.

THE CRY FOR FOOD HAS ECHOED DOWN THE DIM corridors of time. For centuries the human race was hungry, and man's fear of hunger bred greed, suspicion, and devastating wars.

Dreadful famines march in ghastly pageant across the pages of history. England was swept by famine nine times from 1315 to 1709. There were bread riots in New York as late as 1837. Even World War II was followed by starvation of vast numbers.

Life through the ages has been a search for food. Yet it remains a riddle why leaders and nations seemed to think last of agriculture. Ancient Egypt dwelt on fame, Greece on genius, Rome on empire, none on the easier and more abundant production of food. So for ages men and women—gnarled, bent, despairing—toiled in fields from sunup to sundown, scratching the soil with a stick or snipping and gathering grain stalks.

Our own country had had independence for half a century before the first reaper rattled and clattered to success on a backwoods farm in a lovely mountain valley of Virginia. Its impact was tremendous. It pushed the American frontier westward at rapid pace. It built mills and factories and railroads with wheat money, and civilization followed the wheat from Chicago to Puget Sound. Its inventor, a farm boy, had thus gently lifted the sickle and flail from the tired hands of millions of toilers and enriched farmers in many lands. He was Cyrus Hall McCormick whose priceless gift to agriculture created fabulous wealth.

Before the Scotch-Irish McCormicks left Ireland, they invested their fortune of a thousand dollars in linen and touched a neat

profit in its sale when they reached Philadelphia. The great-grandfather of Cyrus had fought Indians in Pennsylvania; his grandfather had fought the English in the Revolution; his father had fought Virginia rocks and had sweated a living from the soil for his family of nine.

By the time Cyrus was born, his father, Robert McCormick, had acquired 1,800 acres of rugged land and had a sawmill, a small flour mill, a blacksmith shop, and little money. This was in 1809, the same year three other world figures were born: Darwin, Gladstone, and Lincoln. Like Lincoln, Cyrus was born in a log cabin; both rose to fame in Illinois, and both were buried under Illinois soil. But they never got on together.

Cyrus' father had made his fields pay despite a greater interest in farm mechanics than in actual tilling of the soil. From earliest childhood Cyrus had watched his father tinker over a queer-looking contraption he called a reaper. Robert would tell fellow farmers what magic it would work once he got it going. They would listen politely, but some regarded the effort as a colossal joke, a stupendous bit of drollery, in spite of the fact that the senior McCormick had invented a hemp brake and cleaner, a hydraulic machine, a faulty hillside plow.

Like most inventors, Robert McCormick was given to dreaming dreams. Fortunately for him and the family there was Mary Ann, his wife, who had her own practical ideas, as well as her dreams for the three boys. Barefoot and dressed in her own homespun, the boys were always early at their places in the old field log schoolhouse. She could, and did, on occasion, work with them in the harvest field, raking and binding grain.

In the meantime, Cyrus, too, had thoughts of his own as to what he meant to do. With one eye on his father's unworkable reaper, he busied himself with skillful improvements on his father's grain cradle, and with inventing an entirely new hillside plow. He was past twenty, a big fellow, hard as the Virginia hills, when his father finally abandoned the reaper, put it aside with a gesture of finality, and left the boy free to tackle it for himself.

In the Old World, others were recording patents for all kinds of farm machinery, including reapers. But the quiet valley of Virginia was far removed from Europe in those days. News of

such patents never reached Walnut Grove Farm, with its busy blacksmith shop, where young Cyrus was tearing his father's reaper apart and was preparing the construction of one entirely his own.

Thus when he had finally completed his model, he had, without any aid whatsoever, except the light of his own genius, embodied in it those essentials that a successful reaper should have. It was the first practical reaper in the history of mankind. It was clumsy but it would reap. The most elaborate reapers of today are direct descendants of the crude machine created by the young Virginia farmer in 1831, at the age of twenty-two.

He had wanted to complete the reaper for that year's harvest but it was too late, save for a patch of wheat that purposely had been left standing. To this his parents and his excited brothers and sisters gathered on a July afternoon. Long shadows were slanting from the tall and jagged Blue Ridge, high above the deep ravines, as he hitched a horse between the shafts of his reaper. Straightway he drove into the yellow field. The reel turned and swept the gentle wheat downward upon the knife. The bright steel blade shot back and forth with a click, click, click. The severed stalks tumbled upon the platform in shimmering golden heaps.

It was a magnificent demonstration despite a few weaknesses, and that night was a joyous one in the McCormick home, where voices were lifted in prayers of thanks.

Not until the next year did Cyrus risk a public demonstration. A hundred people gathered near the little town of Lexington, eighteen miles south of the farm. He ran the reaper into a field owned by John Ruff. The plot was hilly, the reaper jolted and slewed, and Ruff finally shouted: "Stop your horses. You're rattling the heads off my wheat."

The crowd jeered, especially laborers who drudged fourteen hours a day for less than five cents an hour and still feared loss of their livelihood. Cyrus was crestfallen.

Just then the adjoining farmer, William Taylor, called out:

"I'll give you a fair chance, young man. Pull down the fence and cross over."

On this flatter land Cyrus reaped six acres of wheat before sundown; then the machine was driven in victory to the town

courthouse square, where farmers, wide-eyed and open-mouthed, searched for its magic.

It was three years later, after much refining of his machine, that he took out his first patent. Thus given a measure of protection, he went ahead building machines in the family blacksmith shop against obstacles that would have taken the heart from one of less courage. His material, all of it, had to be shipped to him, first by canals, then to the farm over twisting, rugged mountain trails. The six-feet-long sickles he balanced across the backs of horses and carried them forty miles over the hills.

Disaster hit in 1837 when an iron smelting furnace he had been operating failed, and the family struggled for several years to replenish depleted funds.

But in spite of all he kept moving; he sold two machines in 1840, and sold twenty-nine in 1843 for some $3,000. Swept by desire to get his machine out on the flat prairies, Cyrus established a small factory on the Lake Erie shore of western New York in 1844. His brother Leander took a load of material from the old blacksmith shop by wagon and water across Virginia, by boat around the Florida tip, and up the Mississippi and Ohio to Cincinnati, where he set up a branch that same year. Reapers began moving up the Ohio valley in increasing numbers, and their click, click began to be heard in the Atlantic states.

Back on the Virginia farm this initial success was watched by Robert McCormick with deepest gratitude; but he had continued to work too hard; he caught a cold, arose from bed before he should for spring planting, and soon passed away. Cyrus McCormick, successful, robust, and afire with determination, bowed his head in grief, and then tried to fight off that grief with harder work.

"I must get west," Cyrus kept repeating. At length he started, and his 3,000-mile trek of the prairie states, much of it by horseback, finally ended at Chicago, the youngest, ugliest, most forlorn of all the cities he had visited. It lacked common comforts and some necessities. It was definitely poor.

But it had powerful leadership. With swift glances this leadership sized up the ruddy, heavy-set, dark-haired man with the reaper, who was preaching a gospel of hope. Men listened with the stillness of statues as he told how wheat was rotting in Illinois

fields because there were not enough men, women, and children to harvest the crop in the short season; how Chicago could become the hub of world grain trade (which it did), and a center of national commerce. That was in 1847, the year before Chicago received its first telegraph message; the year before the opening of the Chicago Board of Trade.

"How much do you want for a half interest?" asked William B. Ogden, first mayor of Chicago. McCormick named a modest sum and the deal was closed. For the next harvest the company sold $50,000 worth of reapers. At the earliest opportunity, McCormick bought out the wealthy Ogden, who was happy to turn a neat profit, and thereafter it was a one-man business for the founder of a new dynasty of commerce. England's repeal of the Corn Laws had opened up a new market for our wheat; discovery of gold in California boomed the sale of reapers by making money plentiful and labor scarce. So by 1851 the Reaper King was turning out a thousand reapers a year, regarded then as an astounding achievement.

He suddenly found himself not only rich but famous, for that same year one of his reapers had taken the grand prize at the London World's Fair. The *London Times,* which had called it a cross between a wheelbarrow and a flying machine, repented and said the reaper was "worth the cost of the whole Exposition." It was seventeen years later on the imperial farm near Paris that Napoleon III fastened the Cross of the Legion of Honor upon McCormick's coat.

By 1859, the year after he had married the beautiful and brilliant Nettie Fowler of New York, McCormick had placed 50,000 reapers on American farms. They were credited with doing the work of 350,000 men, saving vast sums in wages, and cramming the barns with 50,000,000 bushels of grain. He was fifty years old, had a million dollars, and also a collection of battle scars, many from patent fights in the courts.

One of these three-year battles was launched in 1855 against Manny and Emerson, Rockford, Illinois, who were making McCormick's machine, like many others, without license, since his original patent had expired seven years earlier and renewal attempts had been futile. McCormick engaged such top-flight lawyers as William H. Seward, E. N. Dickerson, and Senator

Reverdy Johnson. The shrewd defendants countered with Abraham Lincoln, Stephen A. Douglas, Edwin M. Stanton, Peter H. Watson, George Harding, and Congressman H. Winter Davis—headliners all.

In this battle of giants Stanton outclassed all others in a speech of such devastating power that, Lincoln said later, it drove him, Lincoln, back to his books for more study of the law, and resulted in his later choice of Stanton as his Secretary of War. It gripped the judge and jury and McCormick lost the case. It made such a vivid impression upon McCormick himself that, with characteristic realism, he engaged Stanton for his next law suit.

McCormick's astonishing political acumen had been an asset to the conservative Democratic party. He favored Douglas liberalism as against the stubborn reactionism of Buchanan and the lower South. He was at Baltimore when the Northern Democrats nominated Douglas for president, as against the Southern candidate, John W. Breckinridge. In this situation the inventor saw almost certain success for Lincoln and his radical party ally, Seward, which to McCormick meant business disaster if not civil war. With Jefferson Davis he sought withdrawal of both men and the naming of a third to unite the severed wings of conservatism and postpone the imminent sectional conflict. But the effort failed; Lincoln was elected and Seward became Secretary of State, and dark was the spring of 1861.

In the war that followed, the reaper did the work of a million men in the grain fields, some historians declare. We fed our armies and yet sold other nations enough grain to feed thirty-five million people. After the war the yellow river widened and villages grew into towns and towns into cities.

When fire laid waste Chicago and McCormick's great plant in 1871, the inventor felt tired at sixty-two and was inclined to retire with his millions. He and his wife drove out to the ruined factory, from which smoke was still rising. Workmen gathered about the carriage. The chief engineer asked for instructions. Turning to his wife, McCormick said:

"Well, what shall it be?"

"Build again at once," was her prompt reply, and the workers cheered and threw hats in the air.

Her understanding and faith contributed much not only to his

happiness but to the towering commercial dynasty he had founded. Her pride in him was more stimulating than public honors, even such honor as that bestowed by the French Academy of Science which recognized him as having done more for agriculture than any other living man.

Before he died on May 13, 1884 at the age of 73, he had indeed done much for agriculture and for mankind. He had greatly increased production, he had reduced drudgery, he had opened up vast new lands with gardens sprawling ever to the west. And he had lessened the cries of the hungry.

JUSTIN S. MORRILL

He "lighted candles of wisdom"

JUSTIN S. MORRILL

Born in Strafford, Vermont, April 14, 1810.
Educated at local academies.
Merchant, 1825-48.
Studied Middle-West agriculture, 1841.
Entered politics, 1844.
Retired from business, 1848.
Married Ruth Barrell Swan, 1851.
Served in U. S. Congress, 1855-98.
College Land Grant Act signed July 2, 1862.
Established Congressional Library, 1888.
Additional funds for Land Grant Colleges, 1890.
Died in Washington, December 28, 1898.

HATS WERE OFF. THE FAMOUS FRENCH GENeral, Marquis de LaFayette, was passing by. A dignified cheer arose from the New England farmers fringing the little street. Among them was a lad of fifteen who looked on in hushed fascination. Once he had seen President James Monroe, but now a glimpse of the French patriot was even more stimulating. Seeing important people somehow made him tremble inside.

That night the boy lay awake thinking of LaFayette and Monroe and other great men. But mostly he was grieving over the fact that his own education, on that very day, had come to a close, and for him any flickering hope of fame was dead. The poor, he decided, had small chance. His pillow was wet with tears.

But, as he wrote half a century later, "life does indeed play strange tricks." For the boy became a confidant of presidents, a brilliant authority on farm laws and tariff and national finance. He set up a record, unbroken to this day, for the longest continuous service in Congress. He is best remembered as founder of the land grant colleges which helped to lift American agriculture to its pinnacle of world leadership. His name was Justin Smith Morrill.

Back in 1632, when the country was mostly wilderness, Abraham Morrill had come over from England, and the family had lived in Massachusetts more than a century and a half before moving to Strafford, Vermont, where, in 1795, Justin's father, Nathaniel, built his blacksmith shop on the tiny Ompompanoosuc River.

Justin's mother, Mary (Hunt) Morrill, bore eleven children, only four of whom reached maturity. Justin was born at Strafford in a two-story colonial type house, with white and green shutters, on April 14, 1810, three years after the birth of his kinsman, Henry Wadsworth Longfellow, and five years before the Battle of Waterloo—clippings of which he gathered with the help of a sister.

His attendance at the little red schoolhouse was supplemented by work at the forge and on the family farm. Later he studied at near-by Thetford Academy and Randolph Academy. At fifteen he looked longingly at Dartmouth, to him the seat of all knowledge, but his father was frank: "I cannot send all my boys to college," he said, "yet each must have an equal chance."

Justin declined an $11-a-month teaching post and went to work at the Strafford general store of Judge Jedediah H. Harris, which also served as news center and sounding board for politics. Harris, his model, greatly influenced his life. He progressed rapidly and moved on to the trading metropolis of Portland, Maine, where he gained broad merchandising experience and had his evenings for study.

When he returned to Strafford, Judge Harris made him a partner in a flourishing business of four stores, one on the Canadian border, which had to fight foreign competition and which, incidentally, influenced his later years of battle for tariff laws.

It was the age of Jackson, of national expansion, of hordes of immigrants, of booming business and booming politics, and after fourteen crowded years with the stores, Justin Morrill was able to retire from active business at thirty-eight. He retained bank directorships through which he had earlier met leading financiers; he had served admirably on a committee to help stem the financial panic of 1837.

To broaden his perspective he had spent a summer traveling by stage and steamboat to the large cities of the East and through the Central West; he invested in Illinois prairie land, and wrote glowingly of a cousin's farm: "It... would do eastern hill-bound eyes good to behold."

Strongly backed by farmers, Morrill swung into politics with a vim, slowing down in 1851 only long enough to marry Ruth

Barrell Swan, a school teacher, and set her up in his newly built home.

Slavery questions were splitting the Union, and Vermont Whigs sent Morrill to the party's national convention in Baltimore in 1852, where a three-way fight developed between President Millard Fillmore, General Winfield Scott, and Daniel Webster. Scott was nominated, but the Whigs carried only Vermont and Massachusetts against the democratic Franklin Pierce. Henry Clay, Daniel Webster, and their Whig party all died within a few years.

"I never forgot that lesson in the essentials of party unity," Morrill wrote.

He was elected to Congress by a narrow squeak on an anti-slavery Whig ticket, took his seat December 3, 1855, and remained in Congress until his death forty-three years later.

He was mostly silent that first session except for urging admission of Kansas as a free state; but he did quietly propose a resolution to explore the "... establishing of one or more national agricultural schools...." One section of the resolution slapped at polygamy and at his two fellow Vermonters, Mormons Joseph Smith and Brigham Young.

Next term Morrill's plan popped up again as a bill; it would donate "... public lands to the several states ... which may provide colleges for ... agriculture and the mechanic arts." By strategy that glinted of genius he steered it through both houses with the thinnest of margins. To the disgust of farmers, President James Buchanan used the veto, calling the bill unconstitutional.

Prosperity had been shattered by the panic of 1857, leaving the Treasury short. Morrill later wrote a tariff bill taxing imports to raise revenue, the first of his many tariff measures. Vermont wool growers were taken care of to their delight, and Morrill's re-elections became somewhat automatic.

Tariff was a live national issue in 1860 and was a factor in swinging pivotal Pennsylvania to the Republicans and Lincoln. Sensing the temper of voters, Buchanan signed Morrill's tariff law.

Commented a Boston paper: "Mr. Morrill is yet in full vigor of health, rather tall, with stern Roman features, a clear blue eye,

brown hair, and side whiskers, and a very commonsense look."

Commented the *Richmond Examiner:* "He looks mean in every fiber and lineament of his wretched body. Vulgarity, cowardice, and rapacity are stamped upon his frontispiece."

His tariff legislation was credited with influencing England's sympathy to the Confederacy in the Civil War that followed.

Throughout that bitter conflict of North and South Morrill labored assiduously on desperate problems of finance, taxes, loans, and budget. He was a shining light in each field, and the fruits of his efforts brought repeated warm praise from his staunch friend Abraham Lincoln. He never wavered through expediency, even when his friend Salmon P. Chase, Secretary of the Treasury, fostered the "greenback bill" of 1862. Morrill attacked the measure as unsound and un-American but it was enacted. Curiously, in 1870 when this law finally came before the Supreme Court, Chase, then Chief Justice, agreed that the act was unconstitutional, and used Morrill's arguments of eight years earlier.

In the midst of national chaos Morrill's dream of land grant colleges remained uppermost in his mind. He introduced his bill again in the House, and, as before, the Committee on Public Lands reported it unfavorably on May 29, 1862. Anticipating the action, Morrill had had his friend Ben Wade of Ohio offer a like bill in the Senate, timed to hit the floor just prior to the unfavorable House report. Six times the bill was tossed aside by Senate debate, and then it was passed on June 10.

Quickly Morrill introduced a substitute bill in the House for the one lost in committee action. By superior strategy he maneuvered it to rapid passage, and on July 2, 1862, President Lincoln happily signed the act which gave birth to our great state agricultural colleges of today.

In the earlier bill that Buchanan had vetoed, each state was to be given 20,000 acres of public land for each senator and representative. It was discovered that in the bill finally enacted the canny Yankee had upped the figure to 30,000 acres. Across the land farmers rejoiced. Their spokesmen said he had "lighted candles of wisdom."

Eastern states without public lands were given scrip for Western lands which they sold to create educational funds. Such funds, under the act, must be invested in state and government

securities "at not less than 5 per cent" and the "capital shall remain forever undiminished." This crippling restriction was later corrected.

Some states, such as New York, did splendidly. Morrill's own state could not find a suitable site, and so combined the new agricultural college with the University of Vermont. Most land grant colleges now have the state incorporated into their titles, such as Ohio State University and the University of Illinois. Others that have benefited by the land grant include Cornell, Dartmouth, Brown, Purdue, Rutgers, and Yale.

Today there are forty-nine agricultural and mechanic colleges for white students in this country and one each in Puerto Rico, Alaska, and Hawaii. Seventeen states have separate institutions for Negroes.

Morrill's big job was done, but agrarians still demanded his continued leadership, and when the two Vermont senators died within a few months, Morrill was elected to the Senate, taking his seat in March of 1868 without a day's break in continuity of service.

To study foreign agriculture and tariff he had spent the previous summer in Europe with his friend James G. Blaine. He had raked the minds of John Stuart Mill, the economist, Disraeli, Lord Derby, and a score of others. On the "pleasure" side of the journey, Morrill visited the fabulous stables of Napoleon III under the Louvre where four hundred of the world's finest horses were quartered. He was a lover of horses.

As the Yankee from Vermont became more and more of a national figure he held tighter than ever to his salient objective of making education available to the poor boys, "the sons of farmers and blacksmiths." Each session found him fighting the cause.

He was fifty-six when he entered the Senate, tall, spare, slightly stooped, with thick dark hair; he had a life-time of drudgery to his credit. Up to that time he had always regarded his Washington stay as "temporary" and had lived many years at a boarding house.

At last he dared build his own house on Thomas Circle. It was soon filled with Vermonters, and with leaders of agriculture, business, and finance. It became a combination of gaiety and eco-

nomic planning. Dinner guests included party leaders and diplomats and presidents—Grant, Hayes, and finally McKinley. Top-line event was the annual birthday party for Morrill, first inspired by Vice-President Hannibal Hamlin. Invitations were coveted.

At one of these dinners Morrill, always a party man, talked eagerly with Horace Greeley, a Republican, urging the great editor to support Grant for re-election. But Greeley was stubborn; he could not stand the graft that had developed under Grant's administration. He decided he himself would run as the Democratic candidate. It was a most strenuous campaign; it broke the health of both Greeley and his wife, and Grant was re-elected. Morrill was deeply saddened when Greeley passed away at the end of that campaign in 1872.

National expansion continued, the West was developing, and farming was aided by the Land Grant Act, but not enough to satisfy Morrill, for colleges were still weak, with neither enough teachers nor enough students. So in 1872 he introduced a new bill for additional financial aid. And he continued to introduce that bill and fight for its passage for seventeen consecutive years until, in 1890, thirty-three years after introduction of his first bill, he attained success.

The new measure placed agricultural and mechanic colleges on a solid financial footing. Each was given $25,000 a year by the federal government. From the day of enactment the forward impulse was pronounced.

As he grew older Morrill turned his legislative skill for a time toward the beautification of Washington. He served as chairman of the Senate Building Committee, fought the presence of railroad tracks on the Mall, and was instrumental in the completion of the Washington Monument, which had languished for twenty years.

By persistent legislative pressure he gained approval of a half million dollar appropriation for a Congressional Library, and two years later, in 1888, lifted the amount to $6,000,000. Under the force of his drive other projects also were launched.

He was a White House adviser during Republican administrations, particularly on financial problems. President Hayes had urged him to become Secretary of the Treasury, but he felt he

could serve best in his Senate post as chairman of the Finance Committee.

In the Democratic Cleveland administration he maintained his tariff program. His lessened responsibilities gave him time, however, to write learned articles on tariff problems, to write a book, *Self-Consciousness of Noted Persons*, and to resume his life-long reading of the ancient Persian, Greek, and Roman writers. His son James, as chief assistant, had taken over much routine.

The country began to call Morrill the Nestor of the Senate, the Gladstone of America, and the Grand Old Man of the Republican Party. Universities and colleges gave honorary degrees to the boy who had cried on his pillow because his education had ended. He sat for portraits for the Corcoran Art Gallery in Washington, Cornell University, the Senate, and the Vermont Historical Society.

His eighty-eighth birthday party in the spring of 1898 was a gala affair and the social event of the Washington season. No one was more lively and charming that night than the woman he had married forty-seven years before. But when the party was over she fell ill and soon passed away.

Heartsick and lonely, Justin Morrill weakened and died six months later, on December 28. The great and near-great attended memorial services in the Senate and at the Capitol in Montpelier, Vermont.

They buried the blacksmith's boy on top of a knoll in the tiny cemetery at Strafford.

SAMUEL W. JOHNSON

Genius of the Test Tube

SAMUEL W. JOHNSON

Born in Fulton County, New York, July 3, 1830.

Conducted chemical experiments on farm, 1846-48.

Graduate work in chemistry at Yale University, 1850-51.

Studied chemistry in Germany, 1853-55.

Taught at Yale University, 1855-96.

Married Miss Elizabeth Blinn, October 13, 1858.

Director, Connecticut Agricultural Experiment Station, 1877-1900.

President, Association of Agricultural Colleges and Experiment Stations, 1896.

Died July 21, 1909.

OF ALL THE MEN WHO STRUGGLED TO BUILD our agricultural empire none worked with nobler effort than Sam Johnson. Frail, sensitive, self-effacing, son of a semi-invalid mother, he had immense aspirations for the land and for the tiller of the land.

His earnest, determined soul was set upon a single goal. He labored from childhood and sacrificed normal pleasures for his objective; the bright, scintillating surface of life was completely lost to his eye. He lived in the joy of his own toil, and that toil finally raised him upon a pedestal.

In his long uphill fight Johnson applied chemical science to the soil; he is credited with having inspired our network of agricultural experiment stations, out of which have come new types and varieties of seeds and plants, new breeds of livestock and poultry, new orchards of swelling, luscious abundance. He died at seventy-nine regretting the short span of life which obstructs completion of a man's appointed tasks.

The Johnsons traced back to Thomas, who came from England to Rowley, Massachusetts, in 1638, and Robert, a founder of New Haven, Connecticut. It was Sam's grandmother, Esther Hotchkiss Johnson, who yanked the reins from her husband's neck and finished plowing a field so that he might hustle off to the Revolutionary army. Sam's father, Abner Johnson, was the twelfth of her fourteen children.

Born at Kingsboro, Fulton County, New York, July 3, 1830, Sam was taken by his father and mother, Annah Gilbert Johnson,

to a farm at Deer River in newly-opened Lewis County, New York. Until he was eleven years old he was his father's shadow, tramping fields and meadows, hauling hay, herding cows, and gathering eggs; he learned about land first-hand and conversed like a grown-up.

Then they sent him off to school at Lowville with his two older brothers and a sister, and a new world was opened up to him, a world of books. The boy would study with a fervor and intensity that brought red patches to his high cheek bones; when his sister would drag him away to meals, he would be in a sort of trance. He consumed textbooks with a gluttony that astonished his teachers. Hunger for knowledge continued throughout his life.

His greatest thrill, he wrote later, was in his fifth and final year at Lowville when teacher David Mayhew introduced him to chemistry and gave him a book of experiments upon which he labored at home for the next two years while teaching at a local school.

It was in this period that the boy—not merely a textbook prodigy but an original thinker—began a long stream of published writings that whipped up interest in chemical science as applied to the land. His article titled "On Fixing Ammonia" appeared in a thoughtful journal, *The Cultivator,* and provoked wide discussion.

"When the spirit of inquiry and trust," he wrote, "pervades the agricultural community, dissipating prejudice and ignorance, then it may be expected that science will do her perfect work . . . and what perfection may we now anticipate from enlightened practice under her auspices."

Such was the plea for realistic thinking from a seventeen-year-old scientist.

Sam's father, a practical man with a love of farming and a high respect for such professions as law, medicine, and the ministry, read the brave published words of his son with a touch of misgiving. But he was moderately sympathetic even if not sharing the limitless enthusiasm of Sam's mother. He gave the boy permission to build what was later termed the nation's first experiment station, a rude shack near the farmhouse, with weather-proofing and running water, and then added fifty dollars for the purchase of chemicals. Sam's mother contributed her silver wedding spoons to be melted down and used as reagents in his mysterious ventures.

Now Sam trod a path of glory. Up at sunrise, he would hasten through his farm tasks and then hide himself away in the little shack, working late by candle light until driven to his bed in a state of ecstasy:

"First I must tell you of today's startling discovery..."

"Too late, son, off to bed," his father would order.

He drank deep of what knowledge the little shack could afford, and then took a twenty-dollar-a-month, room-and-board, teaching post at Flushing Institute. In her little red trunk Sam's ailing mother preserved the bundle of soul-revealing letters of a dutiful son who in the next two years managed to save $150 and with this sum entered Yale College which had opened a school of applied chemistry.

Here for another eighteen months he absorbed new knowledge from great men for their times—John Pitkin Norton and Benjamin Silliman and his son. He learned of work being done in Germany, brilliant work, and was seized with a frenzy of desire to go abroad. So he taught at New York State Normal, wrote for farm journals, lectured, returned to Yale to work in the laboratory, studied German, received a small financial gift from his father, and sailed for Europe in May of 1853.

So engrossed had he been in his studies that he was astonished to find Europe in turmoil. France and England were fighting Russia in the Crimean War. Victor Emmanuel was strengthening Piedmont, planning a united Italy. Liberals had thrown out Count Metternich in 1848, and Germany and Austria were in a spasm of political change.

Sam Johnson settled down to two years of concentrated study at Leipzig and Munich. He found that Germany, France, and England were in advance of his own country in applying science to agriculture. And well they might be, for even then in Europe there was little new desirable land; as our own seacoast land wore out, our settlers simply moved westward to fertile virgin soil.

German scientists soon opened their minds and their hearts to the pale, serious chap with dark bushy hair and eyes that kindled with eagerness. He wrote of their work, and of his own, in a new magazine, *The Country Gentleman*, launched by Luther Tucker, publisher of *The Cultivator*. He insisted, in an article in February, 1854, that agricultural societies must make experiment stations

"their care and pride" if they would accomplish the ultimate end of "perfection in agriculture."

And perfection was Sam Johnson's goal, a destiny that caused him to sacrifice comfort, good clothes, and good food, to hold to his superb singleness of purpose, and to exercise a magnetism of inspiration and stimulus upon others. "We do not have ideas," wrote Heinrich Heine. "The Idea has us and enslaves us and scourges us and drives us into the arena to fight for it like gladiators."

Sam returned to Yale and fought for his Idea; he held dual professorships in the famous Yale Scientific School, and served as chemist for the Connecticut State Agricultural Society, which he had electrified with his findings on fertilizers: he proved, among other things, that some fertilizers selling for four dollars had only 35 cents worth of ingredients. Manufacturers fumed but made no denials. Sam drove out poor fertilizers and later obtained a state law, the first, forcing ingredient labels.

Four times in a single year—1859—he presented new findings before the Smithsonian Institution at Washington on albumin, gluten, and casein in foods; the uses of tillage, drainage, and fertilizers on crops, and the value of lime; he revealed his surprising conclusions on peat and muck, which had been reached in his laboratory, a private house soon to become a scientific center.

He had cast up his accounts in 1857 and found his annual income had swollen to $1,160; so he married Miss Elizabeth Blinn, a teacher, and the union proved a happy one.

Research and development were severely curtailed with the outbreak of the Civil War, but a lift came in 1862 when President Abraham Lincoln signed the Morrill Act establishing land grant colleges. Yale's Scientific School (which became the Sheffield Scientific School in 1861) was made Connecticut's state agricultural college. Johnson flew into action and stimulated other chemists and natural scientists in various states to resume their research work.

His proudest hour, he wrote later, was that of election at thirty-six to the National Academy of Science at Washington. Another proud day, after twelve years of Yale lecturing, was marked by the publication of his famous volume, *How Crops Grow*, with its

illustrations of chemical formulae and diagrams of plants and analytical apparatus. Its success was spontaneous, with translations in German, Swedish, Italian, Russian, and Japanese. Johnson had begun pointing new ways even to the masters in Europe.

Now the frail scientist was forced to pause and spend the summer of 1870 in the Adirondacks in a fight against malaria. But he found time to write the companion book, *How Crops Feed,* also a huge success, and to translate a German work on quantitative analysis in chemistry.

Then he resumed his lectures and writings in behalf of a state experiment station, compaigned the entire year of 1874, and the next year tasted mild success when the legislature appropriated $2,800 a year for two years for a station at Wesleyan College. Professor W. O. Atwater, a former star pupil, was made director. Orange Judd, the publisher, gave $1,000, but this was wholly against the wishes of Johnson, who in his lectures at Yale and across the country had insisted there should be complete independence from private business.

Health continued to decline and Johnson was permitted by Yale to spend another year in Europe... "the first time since boyhood he had gone twelve months without issuing a single publication," commented a co-worker later.

Refreshed, eager, and radiating optimism, he returned to America and drove the legislature into enactment of a law establishing an independent Connecticut Agricultural Experiment Station "for the purpose of promoting agriculture by scientific investigation." In three weeks it was being equipped, and Johnson, himself director, wrote the first bulletin with an Edison electric pen and duplicating press on August 18, 1877, and distributed copies to newspapers, farmers, and farm societies. At last his major fight had been won.

For five years the station remained rent-free at Yale's Sheffield School. Johnson retained his own Yale professorship. In 1882 the station was granted $25,000 for its own building and equipment, and an annual state allowance of $8,000, plus license fees collected under a new fertilizer law.

Students and staff alike found Johnson's enthusiasm infectious; many tests were run simultaneously, and students were given

marked freedom in publishing their findings. The farm world watched closely, and so did the farm politicians, and in 1887 came passage of the Hatch Act under which federal funds were allocated to the state experiment stations. Today there is at least one station in each state, and one each in Hawaii, Alaska, and Puerto Rico. The yearly federal appropriation to supplement state grants exceeded $7,000,000 in 1947.

Johnson had to enlarge his Station staff in 1888 and so he engaged Thomas Burr Osborne, a twenty-eight-year-old New Haven chemist. In the course of the next few months Johnson suggested that he begin a study of the quality, structure, and composition of protein in seeds. Osborne immediately undertook the work, which he conducted at the Station for a period of forty years, himself becoming a scientist of stature. He also married Johnson's only child, Elizabeth, and set about refitting the private laboratory in Johnson's home. They lived next door to each other on Trumbull Street in New Haven. Says Osborne's biographer:

"They were in daily contact for nearly thirty years, Johnson the scholar, the master of the literature, the administrator; Osborne the clear and logical thinker, the determined investigator, the careful experimenter."

Having become a world famous authority on plant nutrition and chemical values in fertilizers, Johnson moved into new fields. He brought about passage of a state pure food law that functioned admirably and remained effective until passage of the federal pure food act in 1906. He was called upon frequently as an expert witness in court cases, for lawyers liked his deliberate and crystal-clear testimony. Honors were heaped upon him, including the presidency of the Association of Agricultural Colleges and Experiment Stations, which he always insisted were inseparable units.

As he approached seventy his uncertain health gave him increasing concern; he reduced his lecture engagements, and his published articles were fewer in number; he became Professor Emeritus at Yale, but clung to experiment station duties, directing his assistants in the writing of bulletins and articles, for which the agricultural world was increasingly hungry.

By the turn of the century the white-haired scientist with

delicate features, and character etched in every line of his face and every movement of the body, was forced to step aside. Even the thick-lensed glasses could give little aid to his failing vision.

He could only putter about, dismantling his priceless library—part going to Yale and part to the experiment station—and sit in on major problems concerning science and chemistry of the soil.

Twice in two years he was struck down by pneumonia, and then on July 21, 1909 he passed away from a heart attack.

WILBUR OLIN ATWATER

Master of Nutrition

WILBUR OLIN ATWATER

Born in Johnsburg, Warren County, New York, 1844.

B.A., Wesleyan College, Middletown, Connecticut, 1865.

Ph.D. in Chemistry, Yale University, 1869.

Studied in Germany, 1869-71.

Married Miss Marcia Woodard of Bangor, Maine, 1874.

Became professor of chemistry at Wesleyan College, 1874.

Director of America's first Agricultural Experiment Station, 1875-77.

Proved plants take nitrogen from the air, 1881.

Became Director of Storrs, Connecticut, Experiment Station, 1881.

Chief of Office of Experiment Stations, Department of Agriculture, 1888-91.

Began Farmers' Bulletin and Experiment Station Record, 1889.

Published calorie tables, 1896.

Died in Middletown, 1907.

HE WAS A SHORT, STOCKY MAN WITH A NOBLE head, firmly supported between ample and compact shoulders. His deep brown eyes were intensely alive and shone like dark fires beneath shaggy brows, and crow's-feet wrinkles marked their corners.

He was born Wilbur Olin Atwater at Johnsburg, New York, May 3, 1844, son of a poor Methodist minister who seemed ever on the move from one rural community to another, saving souls and eking out a scant living. It was an age of "brimstone and hell fire" and people took their religion straight, like their whiskey; but they were sparing of coins when the plate was passed on Sunday.

Sixth generation of the family in this country, Wilbur Atwater talked little and wrote nothing of his boyhood which, in light of his unusual ambitions, must have been rugged as he fought his way up the ladder of knowledge.

Before he died at sixty-three his studies of nutrition had established fundamental laws that have become the basis of scientific feeding of human beings and farm animals. He was first to determine the accurate nutritive value of American farm products. He took his place, unquestioned, in the gallery of famous builders of our agriculture.

When Wilbur's father, W. W. Atwater, settled down to the editorship of a religious magazine, the boy supplemented his spotty public school education with two years at the University of Vermont. Then he worked for a time before entering Wesleyan

University at Middletown, Connecticut, a community which became his center of interest for life.

He had intended becoming an engineer, but his contacts with farmers at various teaching posts changed this course of thinking. Agrarian leaders liked him and told him persuasive tales of what science could do for agriculture.

So he entered Sheffield Scientific School at Yale, forthwith became a star pupil, and by brilliant work took his Ph.D. degree in a year with a thesis on the chemical composition of sweet corn. Some authorities term it the first paper in which modern chemical methods were applied to an American food product. His professor, Samuel W. Johnson, under whose spell he had quickly fallen, made no effort to conceal his delight.

"My friend," said Johnson, "I am convinced you have the mold of greatness—if you will continue hard work."

Atwater smiled. "Thank you, sir. I am destined to work hard till I die."

Between the two a strong and enduring bond had been sealed.

Two years spent at Leipzig and Berlin broadened Atwater's basic conception of a new subject of the day—physiological chemistry—and this later served admirably in his studies of plant and animal nutrition. These studies he pursued with dynamic determination as professor of chemistry at the University of Tennessee, at the University of Maine, and finally at Wesleyan.

It was in 1874, right after his marriage to Marcia Woodard, that the first of Atwater's many arresting articles began appearing and drawing wide attention to his conclusions. He was engaged as director of the first state experiment station in the United States, located in that period at Wesleyan and later removed to New Haven, and served in that post for two years.

The government commissioned him to study food value of fish and invertebrates. His penetrating report was shot through with new indisputable evidence. It was shortly afterward that he explored the age-old question of what makes grass green. His findings included the fact that leguminous plants take nitrogen from the free air. This was deemed a major step toward solution of one of the mysteries of life on the planet.

In the forward sweep of agricultural chemistry, with its profound influence upon the entire nation, Connecticut seemed

destined for outstanding leadership. Two brothers, Charles and August Storrs, gave land, buildings, and funds for the Storrs Agricultural School near Middletown. They made Atwater director both of the school and of its experiment station in 1881.

Under his forceful drive the accomplishments were so remarkable that twelve years later the legislature changed the name to Storrs Agricultural College; it was given the state's share of the land grant fund that previously had gone to Yale. Today it is the long-famous Connecticut Agricultural College. Curiously, the experiment station remained permanently at Storrs, in addition to the one at New Haven.

In his early studies Atwater had noted a creeping change in eating habits. The great library he later amassed held a wealth of facts on this general subject.

Europe's industrial revolution, as he pointed out, had spread to America. As late as 1840 the American census inquired only whether a man were occupied in agriculture. So long as people lived on farms they could have wholesome, nourishing food, and even early life spent on a farm usually meant a sturdy constitution. But now America was having her second and third generation of urban dwellers and, as Atwater repeatedly stressed, nutrition was rapidly becoming a problem that challenged the scientist.

To benefit by any progress made in Europe, he returned to Germany in 1882.

"It was one of many such trips," Dr. Helen Woodard Atwater, his elderly daughter, told me in Washington. "He took along my mother, my brother and me whenever the visit was an extended one. At six," said the retired home economist, "I was speaking German with ease."

He made friends of the famous German scientist Voit, and Max Rubner, his assistant, and with them delved deeply into a new subject, calorimetry, the science of determining the amount of heat given off by the body. A new beacon was thus lighted for Atwater. It helped guide later research.

His remarkable studies of diets for Massachusetts, in that state and in Canada, in 1886, were followed by a period of administrative work in Washington. Atwater had been an irrepressible battler for the Hatch Act of 1887, which provided funds for

experiment stations. He was made the first chief of the Office of Experiment Stations when the bill finally was passed.

Quickly he had the stations take over the work of listless farm boards, clubs, societies, and conventions; in one year he increased the number of stations from twenty to forty-six; he launched two publications which, in crisp clear sentences, guided the farmer in scientific methods. It was a departure.

He shattered the theory that a scientist is a poor administrator. His work was superb, and his three-year record a challenge to others, even if the dynamo did run low and force him into the Maine woods for an occasional fishing trip. He preached research, research, and more research:

"Future value of the stations will depend upon what they discover of permanent value," he said. "And this must come largely from the most abstract and profound research. To forget this will be fatal." And he added: "I myself must get back to the laboratory."

This he did, and was delighted when Washington put him in charge of nutrition investigations. He was eager to complete the study of heat combustion and calories in the human body.

It proved a long, hard road. He had as his helper Dr. Edward B. Rosa, a Johns Hopkins product, a specialist in the physics of electricity. There were obstacles and stumbling, false roads, setbacks and heartbreaks as Atwater plowed forward with the project for the next five crowded years. One of lesser courage might have tossed it all aside and, in the bleak philosophy of Nietzsche, cried out: "Man is not worth it."

But in 1897, through the science of Atwater, who had wrecked his health, and the technical skill of Rosa, there had been produced the "respiration calorimeter" which for the first time measured the number of calories a human body burned up while engaged in varied types of work. It was, of course, a sensation. It toppled many old theories. It changed the course of certain scientific approaches.

During all the period of struggle to produce the fundamental measurement of calories, Atwater had never permitted the nutrition studies to lag.

His exhibit at the Chicago World's Fair in 1893 had been a bit of a sensation, dividing interest with the notorious Midway, where

Little Egypt was wiggling out dances that horrified church women. With complete equipment and sixteen chemists to help out, food was prepared and analyzed before a wide-eyed public. The demonstrations were surprising in their effect. They stirred popular interest beyond Atwater's fondest dreams and gave immense impetus to nutrition studies throughout the land. He was soon supervising research in twenty states. Results were published by the government.

Special nutrition studies were launched in Indiana, Missouri, Tennessee, and Illinois, all under Atwater's direction. Diets at schools and other public institutions, in hotels and in private homes, rich and poor, were examined with clinical precision.

By 1894 the Congress, somewhat reluctantly, had taken first official recognition of human nutrition as a matter of public concern. Funds had been set aside for research in this field, and Dr. Atwater had, of course, been placed in charge.

He popularized the word "calorie" that year in Farmers' Bulletin Number 23, which became the basic work on nutritive value of food, just as his findings a year later in "Methods and Results of Investigation on the Chemistry and Economy of Food" built a foundation for broad public understanding.

Bulletin 23 recognized the problem of digestion. It contained tables on protein, fat, carbohydrates, and fuel values, and studies on varying families in Massachusetts, Connecticut, England, Germany, Denmark, and Sweden. These tables set forth the caloric values of all foods likely to be consumed by the public.

Their values are still used today in our great Bureau of Human Nutrition and Home Economics, which contributes so much to national welfare.

A monumental work, for that day, followed in 1899 when the government brought out Dr. Atwater's famed study, *Chemical Composition of American Food Materials.* He diagrammed cuts of various meats and broke them down as "refuse, water, protein, fat, carbohydrates, ash, fuel value per pound."

Honors came from foreign countries: from France for developing the calorimeter, from Sweden and Russia and from other nations which had translated and used his findings "as a blessing to mankind."

Carnegie Institute of Washington had decided to endow work

on calories, and was preparing to build Professor Atwater a special laboratory. Atwater was to relate information on diet and labor-power to the success and health of nations throughout the world. But he had no strength left for such a task.

In 1944 the Department of Agriculture dedicated a bulletin to Dr. Atwater on the one hundredth anniversary of his birth. Wrote Dr. Henry C. Sherman, chief of the Bureau of Human Nutrition:

"... it is now clear that habitual use ... of the science of nutrition can so increase the efficiency and extent of the fully productive years as to greatly improve one's prospect of attaining life's ideals...."

Drudging endless hours over his test tubes in the quiet of his laboratory, sacrificing health and normal pleasures, the true scientist often receives less public acclaim for his gifts to the race than does that self-seeking humbug, the professional politician, who with ghost writers and booming voice whips up public admiration and sometimes carves a niche in the hall of fame.

Atwater, the scientist, not only helped to build agriculture by applying nutrition to farm animals. He helped to build a stronger race; he brought better health and longer life to men, women, and especially to children, in this and other nations. In so doing he destroyed his own health at sixty and died three years later on September 22, 1907, at his beloved Middletown.

Such was the lot of the scientist that it was twenty-three years before any public note was given to his memory: then a new laboratory at the Storrs Station was named the Atwater Laboratory.

SEAMAN A. KNAPP

Schoolmaster of Agriculture

SEAMAN A. KNAPP

Born at Schroon Lake, New York, December 16, 1833.
Graduated from Union College, 1856.
Married Marie Elizabeth Hotchkiss, 1856.
Preparatory school teacher in the East, 1856-66.
Preacher, teacher, farmer, and editor in Iowa, 1866-86.
Headed immigration and rice growing in Louisiana, 1886-97.
Introduced Kiushu rice from Japan, 1898.
Fought cotton boll weevil, 1903.
Fostered Demonstration Farm, 1904.
Began county agency work, 1906.
Died April 1, 1911.

ACROSS INDEPENDENCE AVENUE IN WASHINGton there are two overhead arches connecting the Administration Building of the Department of Agriculture with the sprawling South Building and its 4,500 offices and eight miles of corridors. Over these "bridges of fear," as they are facetiously termed, men are summoned to the Secretary's office in the Administration Building for conferences, instructions, praise, and sometimes dismissal.

One arch is in recognition of the public service of James Wilson, Secretary of Agriculture for sixteen years, from 1897, under McKinley, Roosevelt, and Taft.

The other is in honor of Seaman Asahel Knapp. If you were to ask a Southerner about Knapp he would call him the great benefactor of Southern agriculture, the man who developed the rice crop, and who fought the boll weevil.

A Northerner would say he improved the midwest breeding stock by importing into Iowa registered swine and cattle; that he laid the foundation for our 4-H Clubs with their 1,600,000 boys and girls; and that in the sunset of life he created what is now the expansive Agricultural Extension Service.

A man of the cloth would refer to Knapp as a preacher of the gospel, a teacher of the blind, and an editor of exceptional perspicacity.

All would be right in their appraisals of this remarkable and versatile American. The memorial arch is, in fact, feeble recognition of his achievements.

"What a man hears he may doubt," wrote Seaman Knapp. "What he sees he may possibly doubt, but what he does for himself he cannot doubt." That was his philosophy. He was a doer from childhood, and throughout life he implored farmers to discard theory and nail down the facts. They followed him, hundreds of thousands of them, and called him the Schoolmaster of American Agriculture.

His ancestors, Nicholas and William Knapp, landed in Massachusetts three and a quarter centuries ago with Sir Richard Saltonstall and other members of John Winthrop's organization. For seven generations they were farmers, although Seaman's father, Bradford Knapp, learned medicine by apprenticeship and was called Doctor, except by his wife, Rhoda Seaman Knapp, who called him Captain, his rank in the war of 1812.

Seaman was the eighth and last child, born December 16, 1833, at Schroon Lake, a wilderness clearing twenty miles west of Lake Champlain's famous town of Ticonderoga. The family moved on to Crown Point, New York, on Lake Champlain, and here on the farm Seaman worked like a beaver. While still in his teens he was regarded as a finished, capable farmer.

He wanted to go to college when time came, an arresting thought in a family which had not had a college man in seven generations, and which grew its own food, spun its own garments, and bartered its goods in the absence of currency. Such lofty notions were disturbing to the hard-working clan, but the boy's burning ambition at length moved his sister Mary to give him the hope-chest money she had acquired by teaching.

So the tall, robust boy of sixteen entered Troy Conference Academy at Poultney, Vermont, working meantime as a farm hand, and four years later became a classics and "mechanics" student at Union College, Schenectady, the first college to raise science to an equal level with the classics. He moved along rapidly, graduated in 1856, and married Maria Hotchkiss. Both promptly became teachers at Fort Edward Collegiate Institute for a combined income of $300 a year and board.

In the Civil War period student bodies shriveled. Knapp's old preparatory school had fallen on hard times and was acquired by the Reverend John Newman, William Y. Ripley, and Knapp, and the name changed to the Ripley Female Seminary, first Vermont

school to issue degrees instead of diplomas to women. Surprisingly it advocated outdoor athletics for women.

Near the end of the first year, Knapp was playing a form of baseball with the girls when he slipped and tore his right knee on cobblestones. The leg began to wither and his health failed. Doctors agreed he could live but one year even with amputation, which he violently rejected, and prescribed an outdoor life.

Here Maria took charge. In 1866 she moved her crippled husband and two children to Iowa, whose prairies were filling with pioneers and whose population doubled in the 1860's and redoubled in the next decade. On land near Vinton they settled, and her father supplied a flock of prize Merino sheep, but in the first bitter winter the entire flock perished.

At the nadir of physical and economic misfortune Knapp said: "Everything I touch seems to wither like my leg."

But he mustered courage and fought on. Having the title of "Reverend," he became pastor of the Methodist Episcopal Church at Vinton in 1867, preaching from a high stool and moving about in a wheel chair. In two years he built up a surprisingly large congregation, organized a local Y.M.C.A., and then taught at the state school for the blind for five years, installing advance methods that set a pattern for the future.

Things had begun going better for Seaman Knapp when a second curious accident occurred. He slipped and again injured the weakened knee. Excruciating pain returned, but immediately a healing process set in and shortly he was walking without crutches for the first time in eight years. The faithful viewed this as a reward for service to fellow man.

Through the dark years Knapp had continued his study of scientific farming; he had headed numerous agrarian groups, had returned to farming in earnest in 1875, had poured forth a stream of learned articles, had edited various journals; he had brought into Iowa fine Poland-China and Berkshire swine, launching a movement of deep and permanent influence upon stock raising. His Crown Prince was called "the most celebrated sire in the world."

He fought constantly for an agricultural experiment station in Iowa, and in 1879, at the age of forty-six, with his health returned, his body sturdy and vigorous, he was elected professor of agri-

culture of Iowa State College at Ames, and rose finally to the presidency, after having rejected such offers at Kansas State and Purdue. Here again he showed exceptional genius, for in a few years he had built, under a small and wavering school, a solid foundation upon which there later arose one of the world's great agricultural colleges.

Knapp was instrumental in tying together experimental stations and agricultural colleges. It was part of his philosophy of "learning by doing."

Iowa's agriculture had found its footing. Knapp had even brought down by 20 per cent the unholy interest rates charged farmers by a big Connecticut insurance company. Now he was bursting with energy and seeking new pioneering adventure.

There was a plan afoot to colonize a million acres of marsh and prairie grassland between the timberline and the coast of the Gulf of Mexico, and in 1886 he moved his family to Lake Charles, Louisiana. His job was to determine what crops would grow in an area the size of Delaware and inhabited only by 'Cajuns, descendants of Evangeline's people exiled from Nova Scotia 130 years earlier. They produced thin crops and scraggy cattle; some rice was grown, being sown in broadcast manner and cultivated as described in the Bible.

Knapp went to England and raised necessary capital. He persuaded midwestern farmers to move into the area, and he established modern farms. Machinery which they brought promptly sank into the rice-growing marshlands. So they were taught to flood, then drain, reflood and redrain with fresh water from subsurface wells. Maurice Brien adapted the binder to rice culture and thereafter farmers were able to use their wheat machinery.

Fights over tariff laws developed and Knapp won out by forming the Rice Growers Association, of which he was made president in 1892. Financial difficulties delayed progress. So he brought in new capital and induced New Yorkers to set up at Lake Charles the first of the Louisiana rice mills outside of New Orleans. Then he banished the old system by which the mills ground rice for a percentage of the flour and let farmers do what they could with the remaining flour. The mills thereafter paid cash for rice as it was delivered.

By the time he had established the *Rice Journal* and *Gulf Coast Farmer* in 1897, he had a shining record of achievement, for he had colonized an area, brought in large capital, and lifted the small and shaky rice industry into national importance.

Next year his friend James Wilson, secretary of agriculture, sent him to the Orient in search of new rice varieties. The war with Spain was on and he was captured by Aguinaldo's forces in the Philippines but talked himself free. From Japan he introduced the Kiushu rice seed, sent other types from China, and the next year wrote an invaluable work, *Present Status of Rice Culture in the United States.* Later he introduced rice varieties from Mexico and Puerto Rico and reported on improved milling methods.

Now, at sixty-eight, his mutton-chop whiskers white against a pink face, his eyes sparkling with enthusiasm, he tackled the Mexican boll weevil which was causing panic and despair in Texas.

Methodical, realistic, and a natural leader, he held innumerable meetings with business men and farmers, conducted exhaustive research, and came up at length with a simple answer. His studies proved that good farming, close observance of known scientific rules, would measurably help curb the boll weevil as well as plant diseases.

Cotton farmers listened with respect and with some doubt. Proof was needed; so Dr. Knapp agreed to put on a demonstration at a cost to the government of $1,000, on the farm of Walter C. Porter near Terrell, Texas. Success of the demonstration brought rejoicing throughout the land of cotton, and Knapp's popularity began to skyrocket.

Washington officials hastened to Texas to study the "Terrell Plan," and Congress set aside $40,000 for the work which was extended to Louisiana and Arkansas in 1905, and to Oklahoma and Mississippi the next year. Methods were simplified and applied to one state after another.

Chief snag in the system was the cost to the government. It was a nettling problem that had to be beaten, and one that kept Knapp awake nights during a trying period when the demonstration work had him shuttling back and forth across Dixie.

Finally he hit upon a plan. Farmers, bankers, and railroad agents had been spreading the gospel of the demonstration farm. Colonel E. H. R. Green, Texas railroad president and son of Hetty Green, wonder woman of Wall Street, had virtually placed his organization at Knapp's disposal. It became clear to Knapp that a single agent, working in each county, and directing the individual farmer on his own land, would be the answer.

Shortly there was established by Knapp, then past seventy, the County Demonstration Agent system. It is known today as the Department of Agriculture Extension Service, with a total 1947 budget from the federal government, the states, counties, and farm organizations of $54,000,000, and with 16,200 technical field and office workers.

Skepticism vanished as the skilled agents began visiting farms and doing strange new things that brought more dollars from the soil—more cotton, better pigs and cattle, bigger grain and hay crops, more luscious fruits and vegetables.

"It added up," wrote a Southern spokesman, "to a higher plane of civilization across the nation."

Knapp had made his tremendous contribution to agriculture and had taken his place in the hall of fame.

But he had wanted to reach beyond the farmer himself, to the sons and daughters and mothers. He was impressed by the interest shown among farm boys and he crystallized this interest into Junior Farm Demonstration Work. Thus there was set up a basis for awards in group and county competition and for individual championship awards. The junior corn clubs suggested pig, calf, and potato clubs, all of which later solidified into the 4-H Clubs of today, one of the finest, most constructive movements for the molding of good farmers, good citizens and solid Americans.

With rare skill and strategy, Dr. Knapp solved the problem of getting into the sacred precincts of the sensitive farm wife's kitchen. First he set up girls' garden clubs, then girls' poultry and canning clubs, then saw to it that instructors from these clubs were slipped into the kitchens under what became our nationwide Home Demonstration Agent system.

He directed the mushrooming programs from Washington, with the assistance of his able son Bradford.

But his health failed after the death of his wife of sixty years, and he died ten months later at the age of seventy-eight, on April 1, 1911. He was buried beside his beloved Maria in a plot set aside for that purpose by the great college he had once headed at Ames, Iowa.

STEPHEN MOULTON BABCOCK

The Jolly Scientist

STEPHEN MOULTON BABCOCK

Born October 22, 1843, in Oneida County, New York.
B.A., Tufts College, 1866.
Ph.D. in Chemistry, Göttingen University, Germany, 1879.
Chief Chemist at New York Agricultural Station, 1882.
Moved to Madison, Wisconsin, 1888.
Devised Babcock Test for quality of milk, 1890.
Married Miss May Crandall, 1896.
Developed "cold storage" method of curing cheese, 1897.
Started "hidden hunger" experiments with cows, 1900.
Studied moths and metabolic water, 1906-12.
Became Professor Emeritus at Wisconsin University, 1913.
Died July 1, 1931.

A MAN LAUGHED. IT WAS A DEEP ROLLICKING laugh, a gusty bellow that cascaded down the university stairs and rumbled through the corridors. It brought grins, as usual, to the faces of students and dark frowns to the brows of instructors.

But no one would dare reprimand the irrepressible Babcock, that genial scientist already world famous for toppling the theories of chemical purists and for bringing salutary benefits to farmer and consumer.

Let Babcock laugh; it showed he was working. Students and instructors alike loved the spare, tall, unconventional man with his short shaggy beard, his high brow, and his one twinkling eye, as merry as the eye in a Frans Hals portrait. They liked his easy talk—by no means styled in chiffon—and his gay stories, some as earthy as the barnyard refuse in his test tubes.

Above all they respected his superior genius which, with his tremendous sense of humor and his young man's laugh, he kept to the end of his eighty-eight years. By this genius he helped lift dairying from a sort of pastoral occupation into a vast commercial industry, and he went down in history as one of the great men of agricultural chemistry, a true builder of agriculture.

Stephen Moulton Babcock, an eighth-generation American, was born October 22, 1843 in a white frame house with shuttered windows on the tip of a rise at Babcock Hill, a tiny village near Bridgewater, Oneida County, New York. There was a splendid view, a panorama of gently rolling, lightly timbered fields, with a silver thread of brook twisting its way off to the valley.

Here from early boyhood he had worked in the fields, and here, too, under the guidance of his father, Peleg Babcock, he had learned to feed stock and in the course of a few years had absorbed more about the subject than most farmers in the county. All his long life he continued his intense interest in the feeding of livestock.

He had an inquisitive mind, a genuine thirst for knowledge which was not satisfied by a B.A. degree in 1866 from Tufts College, nor by study at Rensselaer Polytechnic Institute, nor by teaching chemistry several years at Cornell University while operating his farm. The more science he tasted the greater the thirst. So off to Germany he went, and when he returned two years later at the age of thirty-five he had his Ph.D. in Chemistry from the great University of Göttingen.

There he had sat at the feet of the mighty, men who were seeking new chemical facts, not simply hashing over old ones. But some of the tall talk of these wise Teutons seemed a bit fancy to the practical farm boy. He wondered, for instance, about the noted Baron Liebig who intended to revolutionize farming in his laboratory and, among other things, produce an artificial milk superior to that of cows and mothers.

As Babcock helped poke roots and grains and roughage into their beakers and retorts and ovens he wondered too about the soundness of the simple diagram they had drawn for feeding livestock. It held, in effect, that all foods were nothing but proteins, fats, carbohydrates, salts, and water. Such a mixture and balance was all that was needed for beast or man.

In characteristic manner, he had cocked his head and listened. Over and over again his one eye—a bee sting had destroyed the other eye—had studied these chemical formulas which said little or nothing about the source of the food or the kind of food. To Babcock, the farmer, that was a serious if not a fatal oversight.

It was so important, in his opinion, that when he became chief chemist at New York's State Agricultural Station and was ordered to do the chemistry of food-digestion experiments, he brought up a surprise element that stopped the experts dead in their tracks. By precise chemical analysis he showed, using the standard chemical formula, that what went into the fine test cows was exactly, chemically, what came out, as excreta. And he laughed uproari-

ously. The feed was all right. No doubt about that. But he proved the chemical science was asinine. And he told the sober Association of Agricultural Chemists:

"I can make up a non-food mixture which, by the figures of your chemical tests, will have the same composition of any first-class food.... Try soft coal, for instance."

Thus did Babcock start himself and others on a search for a "hidden hunger," the hunger that comes to man and beast stuffed with food but food lacking essentials of proper diet, the essentials that build health and fight off disease. The search eventually led to the discovery of vitamins.

But at New York's Station Babcock's work had only just begun. He went on and built a "viscosimeter" which tests the viscosity or adhering qualities of oils and other fluids when they are present as adulterants. He next devised a method for using the specific gravity of milk to test it. Then he evolved a test which determined the size and number of fat globules in milk.

In the dairy world Babcock had grown in stature, and at forty-four this merry, chuckling scientist was drawn to the University of Wisconsin as professor of agricultural chemistry and chief chemist in the experiment station. There he did his greatest work.

He had become the central figure in a national movement to bring honesty into the dairy industry. So long as milk remained on the farm or in the village there was no great need for testing it. But now there had developed many steps between producer and consumer. Milk was being sold by weight or volume, and there was no way of testing its value. It flowed to the creameries and was all mixed together.

And what of the farmers with the higher grade milk? Well, in self-defense they simply skimmed off the cream and used it for their own dairy products. Others, with less conscience, added a measure of water to their product. The dairy business, in the words of Dean W. A. Henry, was fast going to pot.

So he tossed the problem into Babcock's lap:

"What we must have, Babcock, is a simple, practical test for the amount of butterfat in milk."

Babcock nodded. There was no gaiety here. All agreed that it was the task of a magician to bring up a quick simple test, and the magnitude of the job became more apparent in subsequent months

as Babcock labored day and night in the still of his laboratory, only now and then roaring at one of his own blunders.

At length he came up with a test that worked on all thirty cows of the University herd, except Sylvia, described by some as a Jersey and by others as a Shorthorn. The elated dean urged Babcock to release his findings in light of the growing public unrest. After all, he argued, there weren't many fantastic Sylvias, and things really were in a mess.

But Babcock refused and worked on until he hit the perfect formula. His test was based on the action of sulphuric acid on the constituents of the milk, and the effect of centrifugal force. Babcock's problem was to get the correct amount of acid to dissolve the solids in milk. When dissolved, they liberated the fats. At the same time they generated heat which melted the fat and increased the specific gravity of the water. Centrifugal force separated the ingredients.

Walking into Dean Henry's office he tossed the sheet upon his desk and said:

"Well, there it is at last, sir."

The dairy world was electrified, and in the words of one public man, "it made more dairymen honest than the Bible ever did."

Babcock refused to patent the method for royalty purposes, but gave it "to the world for anyone to use without payment or hindrance." Soon his name was known and praised in every dairy and cheese factory in America, Europe, New Zealand, and Australia, and honors poured in upon him.

It was this simple butterfat test that immortalized Babcock in 1890. In more than half a century it remained unchanged.

Next year the legislature provided funds for a special dairy, and when it opened, with a hundred young men as students, it soon became a mecca for dairymen. Babcock continued research and followed his butterfat test with a method for separating the casein from milk; he concocted a mathematical formula for telling the exact yield of cheese from a given amount of milk.

Then in 1897, a year after his marriage to May Crandall, he developed, with student bacteriologist Harry Luman Russell, later a dean at Wisconsin, the so-called cold storage method of curing cheese. This was good fun and brought many guffaws from Bab-

cock as more theories of the great chemical thinkers were cracked up.

In all his work, never for a day could he shake off his doubts about accepted cattle rations, doubts that had grown in his mind at the New York station. He knew there was more to food than a neat chemical balance. He questioned the doctrines that fellow chemists were proclaiming. He wanted more cows for more tests —actually got a few from the state herd and killed some of them by feeding them oats alone. The school authorities promptly ended these shenanigans.

But Babcock was a patient man, and for the next six years, in idle hours, he would go about in his old grey sweater, his merry eye twinkling behind spectacles, and talk cow statistics; he knew them as well as he knew the batting averages of all major league players. At football games and track meets he would plant himself among the "chemical formula" experts and needle them with questions.

Little candles of doubt thus were lighted in some minds and, more in desperation than of free will, his superiors finally granted his wish. From the university herd he was given sixteen splendid calves.

Babcock set to work with bristling enthusiasm. As helpers he selected two youngsters—E. B. Hart and D. C. Humphrey, a new professor of animal husbandry. He wanted no old fogies or frozen minds muddling in; only young men with fresh vision.

He divided the calves into groups of four. To one group he fed a grain mixture; to another he fed only corn, while the third group had only oats, and a fourth lived on wheat.

Soon it developed that the best cattle were those consuming a mixed ration. Next best and rather good were the cattle living on corn, then came the less healthy oats eaters, and lastly the poor critters existing on wheat. It did not take long to prove that even wheat, the staff of life, held a "fatal hunger" which was passed on to the next generation.

"Make it a lifetime with these creatures; keep at it, boys," Babcock would say, and the work went on and on for several years into generations of cattle, while the evidence piled higher and higher and the old chemical formulas fell into discard. The "single

grain" tests proved highly upsetting to the chemical purists, but most of them were quick to accept the indisputable evidence, evidence that paved the way to discovery of Vitamin A, which work Babcock would now leave to others.

"My boys deserve all the credit," he would insist over their protestations, after the famous Wisconsin Research Bulletin No. 17 had come out relating the fascinating adventures that revealed hidden hunger. Babcock had had fame aplenty and even the state itself had become famous and was rising to heights as a leading dairy state. He had started Hart, the serious Harry Steenbock, and the able E. V. McCollum on their life work of mapping out the foods that caused the hidden hunger.

And he had other work to do, lots of it. But he kept an eye on developments long after he had become professor emeritus in 1913, and after he had bought his first motor car at seventy-seven (he would never have a telephone), and after he had grown his famous hollyhocks which became "Babcock Memorial Gardens" at forty-four state agricultural colleges following his death at Madison, Wisconsin, on July 1, 1931.

One task that held his interest had been started long ago. It was his study of what he called metabolic water, the water that beasts make in the tissues of their bodies. It started when he had noticed that moth larvae have ten times as much water in the tissues as there is in the wool fiber which they eat. He was determined to know where the moth got its drinking water.

For six years he watched generations of clothes moths, flour moths, weevils, and other insects. He found that they lived on water taken from the air in the process of breathing. Many scientists regard his work on metabolic water, or the changes in the form of water, the most important achievement of his life.

Something new, strange, and exciting—he was always finding it in his lonely moth room. The dean, passing by one day, heard a spontaneous outburst of laughter and the exclamation:

"Well, I'll be damned!"

"What is it, doctor?" he asked.

"Why, look... look at these funny little devils gulp their wool...."

THEOBALD SMITH

Conqueror of Texas Fever

THEOBALD SMITH

Born in Albany, New York, July 31, 1859.

Ph.B., Cornell University, 1881.

M.D., Albany Medical College, 1883.

Director of Pathological Laboratory, Bureau of Animal Industry, Washington, D. C., 1884-95.

Completed experiments on cause of Texas cattle fever, 1893.

Joined Massachusetts Board of Health and Harvard Medical Faculty, 1895-1914.

On Board of Directors of Rockefeller Institute for Medical Research, 1901-34.

Director of Department of Animal Pathology, Rockefeller Institute, 1914-34.

President Board of Directors, Rockefeller Institute for Medical Research, 1933-34.

Died in New York City, December 10, 1934.

TEXAS WAS CATTLE POOR FOR YEARS AFTER THE close of the Civil War. Then came a time when the magic of markets transformed the situation almost overnight, and Texas became cattle rich.

Northward there began to move an interminable column of cows, its head often dipping over one horizon, its tail over the other, drifting onward lazily, ten miles a day over the short-grass billows of a treeless expanse of prairie.

As the movement to market from Texas and other southern states expanded with the years there arose a devastating cattle disease; it hit northern cattle hardest but only when they were mixed with southern herds. Victims ran temperatures up to 107 degrees, hunched their backs, drooped their heads, stopped eating, and died. Study of the phenomena only served to deepen the mystery, even to England's brilliant Dr. John Gamgee, who had been called in.

When the economic loss to the cattle industry finally had reached a shocking total, variously estimated up to a hundred million dollars a year, frantic government officials did something about it: They instructed the Bureau of Animal Industry to find a solution.

In those days that sturdy Bureau consisted of its chief, Dr. Daniel E. Salmon, Dr. Fred L. Kilborne, and a colored ex-slave who from time to time tidied up the laboratory. Plainly some additional help was needed to arrest the havoc among cattle; so on recommendation of Cornell University young Theobald Smith

was engaged in 1884 as director of a newly organized Pathological Laboratory. The twenty-five-year-old scientist was given plenty of test tubes and other equipment, as well as a hot Washington garret in which to carry on his vital experiments.

For nine years Smith labored, his insatiable curiosity taking him down many scientific trails, most of them blind alleys. In the end he solved the riddle and wiped out Texas fever, to the everlasting benefit of cattlemen. But he did much more. By proving beyond a shadow of doubt—and for the first time—that an infectious disease could be transmitted by an intermediate carrier from one animal to another, he opened up a vast new field in medical science. He pointed the way for studies which later incriminated such parasites as mosquitoes, fleas, and lice as carriers of human diseases. Thus his was a mighty gift to public welfare.

In Albany, New York, where Smith was born on July 31, 1859, he became distinguished in boyhood for his almost fanatical hunger for knowledge. His parents, Philip and Theresa Schmidt, who had come over from Germany nine years before his birth, were quick to anglicize their name; they also became genuinely patriotic. Both were of school teacher families and they taught Theobald to read and write English and German almost as soon as he could talk.

His father's income as a carpenter would not permit a college education. But at high school he won a scholarship at Cornell in a statewide contest. Theobald paid part of his expenses by playing hymns on the Cornell chapel organ and doing jobs of mechanical skill, and in 1881 graduated with a Bachelor of Philosophy degree. Two years later he received his M.D. degree from Albany Medical College.

He had had no training in bacteriology and little in pathology when he took the government post to combat Texas fever, but this was a slight handicap to such a mind; he taught himself both subjects by intensive study of the published works of Louis Pasteur and Germany's Robert Koch.

On the golden age of medical discovery the curtain was rising, and young Smith drank in knowledge with extraordinary rapidity. Within two years he had established at Columbian University (now George Washington University) the first department of

bacteriology in any American medical school and remained professor of the subject there for nine years.

Such was the background of the conqueror of Texas fever.

He traced the earliest records of the disease back to 1796. An outbreak in Lancaster County, Pennsylvania, was coincident with the movement of a herd of cattle from South Carolina. It was during the great trail movements in Texas, with heavy losses, that the malady had taken on the name of Texas fever.

Smith moved cautiously. His early papers on the subject set forth new facts in careful array, always avoiding generalization. He performed scores of autopsies on stricken cattle in the Virginia outbreak of 1886 and the Maryland epidemic of two years later. When trouble was at its height, he had cattlemen pack in ice the insides of stricken animals and rush them to his attic laboratory. In the spleens he found no microbes at all; but a great quantity of the red corpuscles of the blood were mysteriously broken up. "Here was a new puzzler, indeed," he said later.

As he was preparing for the summer drive of 1889 (the disease hit only in the hot months and disappeared with frost), his assistant, Kilborne, reminded him of the theory of the Texas cattlemen: This theory was that the tick caused the disease; get rid of the tick and you've ended Texas fever, cattlemen argued. Other scientists had laughed off the theory as ridiculous. They had proved that the mature tick itself was not infected. But Smith was impressed by the cattlemen's theory. After all, they lived with the beasts, saw their blood turned to water by the dread disease; lost their fortunes and their homes. Their opinions merited thought.

So Smith built a new laboratory, a crazy sort of laboratory to many scientists and veterinarians who had struggled futilely with the problem. It consisted of a series of open pens under the blistering sky.

Into pen number one Smith and Kilborne placed four cows from the heart of the southern tick fever belt, cows infested with thousands of ticks of all sizes. Into the same lot were placed six perfectly healthy northern cattle.

Then from three other southern cows, amid the heat and dust, they picked off the ticks, every single one of them, large and small, and these cows they placed in pen number two. With them

were corralled four healthy northern beasts, to eat the same field grass and drink the same water.

During the various periods of waiting Smith and another associate studied the lives and habits of ticks. They learned how baby ticks climbed up the legs of cows, fastened themselves to the hide, grew to maturity, and how the fattened females then fell to the ground to lay two thousand eggs and wither and die, rounding out a complete life in about twenty days.

In a few weeks things began to happen in pen number one. The northern cows developed ticks, thousands of them; they turned hot with fever, their blood changed to water, they grew bony and died. The post-mortems were a messy, bloody business. But they brought forth explosive facts.

As the weeks passed and summer drew to a close, Smith continued watching the beasts in pen number two. Here the northern cattle, every one of the four which had been penned up with southern cattle from which ticks had been removed, continued getting fat.

But Smith was a determined investigator, a researcher who wanted more and more facts. So he switched the healthy northern cattle from pen number two into pen number one which was infested with ticks. In sixteen days they were burning with tick fever, and one of them was dead.

Still more proof was needed; so Smith set up field pen number three. From North Carolina he obtained containers of grass, grass literally crawling with ticks. This he spread upon the field before leading in four healthy northern cows. The expected happened; in a few weeks their blood ran thin, their heads were hot, their dry tongues dangled from the side of the mouth.

Smith was a stubborn fellow, never robust, never dominating, but irresistible in his persistence. Some scientists still contended the fever came from eating ticks with the grass. So Smith fed ticks to healthy cows in hay and in a mash, vast numbers of them, and nothing happened.

In his continued research he discovered that northern calves, like southern calves, became immune to the disease and got only a mild fever on fields that would have destroyed their mothers. He even went so far as to hatch baby ticks by stove heat in the

winter and with them infect cattle during months when the disease had not before been known.

Blood from victims of tick fever was studied months on end in the attic laboratory under the most powerful glasses available. Smith began leaning to the conclusion that it was the blood that the microbes attacked; that those strange pear-shaped spaces in the otherwise solid discs of the blood corpuscles held the solution to the mystery. In the course of time, under his lens, he discovered that the queer spaces were indeed living creatures, that they were always inside the blood of tick fever victims, destroying the corpuscles, turning the blood to water.

But he did not hurry to conclusions. First he examined the blood of many herds of afflicted cows and of healthy cows.

By 1891 he had proved beyond doubt that the tick was responsible for Texas fever.

It was not until 1893, however, after four steaming summers of intensive experimentation, that he sat down and wrote his remarkable report, complete, convincing, and so simple a school boy could understand it.

"The true cause of Texas fever," he said, "is a microscopic parasite, belonging to the protozoa, which lives within the red blood corpuscles and destroys them. . . ."

Said Dr. Hans Zinsser, noted bacteriologist: "The report is one of the classics of medical literature. It established beyond question the role of the tick as a carrier of disease. It demonstrated once and for all Smith's extraordinary qualities as an investigator. If he had done nothing else, it would have given him a prominent place in the history of medical science."

Smith called his report "Investigations into the Nature, Causation, and Prevention of Texas or Southern Cattle Fever." It tells the whole story.

Wrote Dr. Simon Henry Gage, one of Smith's Cornell instructors: "Smith opened the road to others for discovery of how insect carriers transmit germs of malaria, sleeping sickness, yellow fever, typhus, spotted fever, and the bubonic plague from individual to individual."

In the government's subsequent drive to eliminate the tick, which included the use of thousands of dipping vats with an

arsenical solution, there were fights, law suits, dynamiting of vats, and even a few killings of inspectors.

Inquisitive Theobald Smith had studied hog diseases along with cattle ticks. He was first to prove hogs were dying of respiratory and digestive diseases. With Dr. Salmon he established the possibility of "actively immunizing animals with the products of bacteria in liquid culture and with the dead bodies of organisms killed at 56° C." This, says Hans Zinsser, led to the "present methods of active immunization in man."

Next Smith tackled, at the Rhode Island experiment station, a disease called "black head" that was killing off the nation's turkeys. It was caused by a parasite, he proved, and his findings were conclusive on prevention.

Busy Dr. Smith had taken time off in 1888 to marry Lilian Hillyer Egleston of Washington, D. C.; after a short honeymoon he hustled over to Cornell and organized its bacteriological department.

In the years after he discontinued federal government work he served on the Massachusetts State Board of Health, on the faculty of Harvard University, and from 1914 to 1929 as director of the Department of Animal Pathology of the Rockefeller Institute for Medical Research, a department he himself had suggested. In 1933 he became president of the Institute's board of directors.

Smith noted, in one of his research projects, that sometimes animals were hypersensitive to bacterial infections and reacted strangely or violently. This became the "Theobald Smith phenomenon" and led to the discovery of allergies.

It was Robert Koch, celebrated German scientist, whose works had aided young Smith so materially, who wrote in 1908: "To Theobald Smith belongs the credit of having been first to call attention to certain differences between the tubercle bacilli found in man and in cattle. It was his work which induced me to take up this same study."

Smith's bright friendly eyes, set in a narrow face and topped by bushy brows, seemed to grow brighter and more eager with years. His wire-like beard and mustache, and his erect carriage, added to a dignity befitting a great scientific mind.

And it was a great mind. In nineteen years Smith wrote fifty-six papers, numerous addresses, and one book on parasitism. He

wrote two hundred and twenty-four medical papers, most of which were eagerly read by medical scientists around the world. He was showered with educational and scientific honors; yet outside of those fields he still is little known despite his extraordinary service to mankind.

To the very end, his mind was always reaching out, seeking new frontiers, setting in motion new projects of research, stimulating the imagination of other scientists. He organized and became first president of the American Academy of Tropical Medicine. Just as it was scheduled to open its sessions in New Orleans, Theobald Smith, the distinguished son of two German immigrants, died in a New York hospital on December 10, 1934, at the age of seventy-five years.

MARK A. CARLETON

Wheat Explorer

MARK A. CARLETON

Born in Jerusalem, Ohio, March 7, 1866.

B.S., Kansas State Agricultural College, 1887; M.S., 1893.

Professor of natural history, Garfield University, 1890-91.

U. S. Department of Agriculture, 1894-1918.

Cereal Explorer in Russia and Siberia, 1898 and 1900.

Introduced Kubanka wheat, basis of U. S. durum wheat industry, in 1899, and Kharkov, hard winter wheat, in 1900.

Died in Piura, Peru, April 26, 1925.

DAY AFTER DISMAL DAY, FROM OUT OF THE west, from the distant Rocky Mountains, the hot wind swept across the flat plains of Kansas. Under skies of brass, filmed with dust, it whistled and whined through the wheat fields, bending the plants close to the ground.

As if withering winds and dust storms were not punishment enough in that 1877 season, horrified farmers watched the dreaded black stem rust skip on the wind from county to county, shriveling wheat kernels and laying waste many square miles of golden grain.

A barefoot boy in knee pants, his skin painted dark by months in the fields, listened to distraught farmers pour out their woe; he solemnly watched some of them pack their chattels and bid farewell to that stern and bitter land.

It was not just one bad season. Year after year the growing boy, Mark Alfred Carleton, heard the same laments, with variations, from hard-bitten wheat growers fighting a losing battle with nature. Then, when he was six feet tall and as hard as the plains themselves, he began doing something about it. And before he had finished he had brought to his country priceless and enduring benefits. Yet by the tragic turn of events he died all but forgotten, and with a breaking heart, far from the prairies he had loved, the prairies he had helped make productive.

He saw many crop failures, did Mark Carleton, but to the end of his days that year of the big winds and the black rust plague walked up and down in his heart like a dreadful specter. Perhaps

it was because he was so new to Kansas. Back in Jerusalem, Ohio, where he was born March 7, 1866, there were trees and hills and now and then a brook for a boy to fish in. His parents, Lewis and Lydia Carleton, had taken a long jump to Cloud County in north central Kansas. This strange new land, bleak and lonely, where men's eyes had a look of desperation, may have twisted the lad's normal ambitions into fanatic determination.

At the very peak of his great work, men called him a dreamer. Yet no fuzzy dreamer gave America its giant durum wheat crop. Others called him a bore and a pest. That was because he had to jam facts into narrow minds of government officials and millers. All were right on one score; he was no glad-hander; he had no more humor than a death mask.

But Mark Carleton knew wheat, and lived wheat, in a land where wheat was life. From childhood he studied the wheat plant, slitting the stems, weighing the kernels. He kept on farming and studying wheat during his years at Kansas State Agricultural College, from which he received his B.S. degree at twenty-one. Now a brilliant botanist, he plodded the fields and studied black stem rust and weather maps while teaching school and later while serving as professor of natural history at Wichita's Garfield University. Nights he studied dead languages—Greek and Latin—to be able to master scientific names of grain types, rusts, and parasites. Still later he tackled Russian.

By the time he was twenty-six, this hulking, silent, slope-shouldered fellow with great gray eyes was attracting attention, and Kansas Experiment Station engaged him to make a study of cereal rusts. Within a year he had made a profound discovery that upset the long-time conviction of top-shelf botanists of America and Europe. They had believed rust leaped from one grain to another—from wheat to rye to barley to oats.

Methodically, Carleton had smeared spores of black stem rust of oats on young tender oats plants and reset them in wheat plats. The rust shriveled the oats but left the wheat untouched. Rusted wheat was similarly planted in oats plats but the oats remained clean. Before this work was finally concluded he had established the physiological relationship of nearly all the cereal rusts in this country.

That was the first step up the ladder of fame. Now the government wanted him, and in 1894 he went to Washington as a vegetable pathologist to study wheat, with a staff of two men and a stenographer. He was overjoyed, for he thus had an assured living and a laboratory that stretched from the Canadian line to the Texas Panhandle. He roamed this land like a hobo, putting up in whatever miserable spot he might find himself at night.

Meantime from his Washington desk he wrote and gathered a thousand samples of wheat from the corners of the world. In rows he planted the various types in a plot in near-by Maryland. The test was a failure. In such a mild climate, free of the icy Kansas winds, the blazing sun and driving dust, nothing of rust or drought endurance was to be learned.

So he repeated the experiment next year at Salina, Kansas. It was a harsh autumn and bitter winter. A film of ice covered the tender blades. Most of them were slaughtered. He picked up the survivors and planted them the following year at the Kansas Experiment Station. It was another bitter winter. Out of the original thousand varieties, less than a hundred remained at the end of the summer of 1897. But these told the botanist a story, a sensational story that only he could read from his endless tables and his stack of cryptic case histories.

"I must go to Russia," he began saying. He repeated it a hundred times a day to all who would listen. "I must go to Russia," he kept writing in memoranda to his superiors. He would break into meetings of stiff-necked Washington officials, and only his intense urgency and sincerity kept him from being thrown through the door. To patient Secretary of Agriculture James Wilson, one of Carleton's superiors finally pleaded: "For God's sake send him to Russia and let us get back to work."

So Mark Carleton left for Russia on Independence Day of 1898. Only on the preceding December 29 he had married Amanda Fraught, who was to be ever a devoted wife, and the mother of his four children. He left his bride behind.

Mark Carleton knew what he wanted in Russia: a hard winter wheat that could be sown in the spring and that could stand dryness and resist rust; and a wheat to be sown in the fall, tough enough to stand wintry blasts. Some of his planted varieties had

given him leads. So had the Russian Mennonites he had met growing wheat successfully in his own Kansas. In the midst of bitter wheat years these quiet religious people were prosperous, with good houses and painted barns. He had quizzed the quaint folk until they were tired of him; he had learned they called their wheat Turkey, that it was hard, that their old folks, the first settlers, had brought it in; that one of their own people ground it. The bread was excellent.

Mark Carleton went to Russia, mumbling his few palate-twisting Russian words.

At Odessa and St. Petersburg and Moscow he picked the brains of agronomists. Then he set out across the barren steppe. His awning-like mustache he poked into barns and tents and village huts and jabbered his questions. He roamed onward and onward all summer and autumn, bothering the peasants no end, and finally brought up at the rim of Asia, on the hot Turghai steppe, just southeast of Orenburg. There his trail ended, for in that dry and sun-baked land he found the Kubanka, a hard durum wheat with long stiff beards, "a wheat that would grow in hades."

Back in America with a big seed supply, he began exhorting farmers, especially in the dry areas, to take a chance; he pleaded with them, shamed them for their timidity, and at length entire states became his laboratories. He got Kubanka seeds into the ground from Texas up to the Red River Valley in the north. It began to perform growing miracles in the Dakotas. Production of this spring-sown wheat kept swelling until flour millers roared disapproval; the wheat was so hard, they claimed, that their machinery would not grind it. They called it Bastard Wheat, and were thumbs down.

But humorless Mark Carleton fought on. He hardly slept those first years. He baked hundreds of loaves of bread and sent them to famous people, including cook book specialists.

Then in 1904 his break came. It was a year of black stem rust. Like a thief this parasite slid stealthily through the fields, blasting Fife and Blue Stem—but leaving the austere Kubanka nodding its noble beard in disdain. Millers began to crack.

Joyfully, Carleton wrote Farmer's Bulletin No. 219, summariz-

ing the happy experiences of farmers who had planted Kubanka and a few sister types of durum. Crop losses from rust in the Dakotas and Minnesota totaled 60 per cent over large areas; Kubanka losses were 3 per cent; sometimes nothing.

"There is little doubt," wrote Carleton, "that if all wheat grown in these states in 1904 had been durum, this loss to the spring wheat crop would have been entirely avoided...."

Strangely enough, the great cereal explorer had brought back the Kubanka principally to stand dryness. Even his own eyes were opened in surprise by its stubborn rust-resisting qualities. The durum wheat crop swelled year after year until by 1930 production totaled 56,000,000 bushels.

But creating the mammoth durum wheat industry was by no means all. At the turn of the century Carleton had hastened back to Russia, this time to far northern points from which the Mennonites had brought their Turkey Red wheat to Kansas. And there in a district drier than Kansas and much colder than Kansas, there at Starobelsk, he found his famous Kharkov, a fall-sown, hard, red-kerneled variety, whose roots dug deep and whose green shoots cuddled the ground to escape icy blasts. It did not take long for this sturdy plant to spread out over western Kansas, creep into Nebraska, and into Oklahoma and out into Montana. Wherever it took hold, new dollars jingled into the farmer's pocket and he rejoiced; and it did take hold and in no time had covered twenty million acres of western plains.

Nor was this all. Mark Carleton established the Swedish select oat; he experimented with the Sixty-Day oat, which became the general-purpose variety planted in this country. He introduced into the Middle West the cultivation of winter barley, thus largely increasing the acre yield of barley. He aided dry farming in the Texas Panhandle.

A press agent, even a mediocre one, could have made Mark Carleton a world figure, with an enduring niche in the hall of fame. His government would not have dared to fire him over the tangle of his pitiful personal finances, this man who gave us the magnificent Kubanka and the brave Kharkov, and who added untold wealth to the nation. Even the French government, in rec-

ognition of his high service on a jury of award, had conferred upon him the order of the Chevalier du Merite Agricole.

"Poor Mark Carleton," as he is always referred to around the Department of Agriculture (from which he departed in 1918) could not manage his personal affairs on a salary that would make a present-day coal miner blush with shame. He tried to supplement his miserable income by borrowing to buy a fruit farm in Florida, and later to dry-farm in Texas. Soon his IOU's were scattered about like confetti. His Washington home was sold from under him; he moved his family to a shack.

A son had a serious operation. Shortly afterward a daughter, a lovely girl in the bloom of youth, fell ill and died quickly and was cremated to save expense.

Mark Carleton wept as he hobbled on rheumatic legs behind the coffin, while a golden wealth of his wheat waved prosperity across the prairies. Another IOU permitted him to have his teeth drawn to relieve the rheumatic pain.

Then a new blow fell. He was given a ninety days' furlough to clear up his debts. He foolishly borrowed a few thousand dollars from a wealthy grain man. That was worse than a crime—it was a blunder. Congressmen, not of the grain man's political party, beat their breasts in horror; yet there was no hint of dishonesty.

Heart-broken and ill, Carleton gathered up his few belongings and left his government job after twenty-four years of service. He wanted to be far away.

Down in Panama, at Boco del Toro, he studied banana diseases for private companies; he studied "cotton wilt" problems for growers at the Laboratoria de Plagas Algodoneras. To banks holding his notes, and to persons holding his IOU's, checks began coming back, checks without comment.

But his spirit was broken, his heart ached, the sun was too hot and the air too wet for a sick plainsman of fifty-nine, a man accustomed to high winds and open spaces and sprawling wheat fields. He died at Piura, Peru, on April 26, 1925.

One day a kindly Secretary of Agriculture, thumbing the dusty records, may feel constrained to suggest some sort of memorial to the man who, single-handed against the crowd, brought abun-

dant new wealth to the prairies. He might even hint that those who profited so directly—grain growers, merchants, elevator operators, railroads, and flour millers—contribute a few dollars each for a statue by some eminent sculptor.

It might picture the tragic wheat explorer, the dreamer, standing there under his broad-brimmed hat, his floppy clothes hanging from stooped shoulders, holding in his hand a sheaf of Bastard Wheat, and looking with wide soft eyes out across the steppes of Russia.

HARVEY W. WILEY

Apostle of Pure Food

HARVEY W. WILEY

Born in Kent, Indiana, October 18, 1844.
Served in Civil War, 1864.
B.A., Hanover College, 1867.
M.D., Indiana Medical College, 1871.
Taught Greek, Latin and chemistry, 1868-83.
Chief Chemist for Department of Agriculture, 1883-1912.
Established and conducted "Poison Squad," 1902-06.
Pure Food Law passed, June 30, 1906.
Married Anna Campbell Kelton, 1911.
Editor and writer, 1912-1930.
Died June 30, 1930.

WHEN HE HAD REACHED THE AGE OF FOUR and was told he must start to school, little Harvey Wiley looked his father dead in the eye and shook his head in a fiery revolt that shocked the household.

His Calvinistic father met the challenge. Seizing young Harvey's hand, he led him to the schoolhouse, drew a chalk ring on the floor, shoved the boy inside the circle, and warned:

"You will learn your lessons here. Leave only on instructions."

Thus did Harvey Washington Wiley, father of the pure food law, begin a lifetime of study that ended only with his death at eighty-six. Across the years his contributions to public health and to agriculture were tremendous.

Much of his long life Harvey Wiley was in open revolt. He revolted against those who hated change. He revolted against greedy interests which put profit ahead of public welfare. He revolted against political humbugs. And he found the public on his side.

Like his sturdy forebears, Harvey Wiley was tall, hard, and tireless. His ancestors on both sides were Scotch-Irish pioneers who had fought in the Revolutionary War, and had been granted land in Kentucky. His parents had moved their small effects across the Ohio River, and it was in a log cabin at Kent, Jefferson County, Indiana, that Harvey was born on October 18, 1844, sixth of a family of seven children.

His father, Preston Pritchard Wiley, a strict churchman, was a farmer, a plasterer, and a village schoolmaster. He taught himself

Greek by comparing the Greek and English versions of the Bible. Harvey's mother, Lucinda (Maxwell) Wiley, had but three months of schooling. But she was skilled with the loom and, with the amazing dexterity of the pioneer mother, managed a smooth-running home.

Moving from the log cabin into a large frame house was an event of quiet rejoicing. There were two stairways, one for the girls who slept in the east upper end, and one for the boys in the opposite end; passage was possible only by going down stairs. In the austere religious atmosphere there was no frivolity—such as exchange of Christmas gifts. Father Wiley read the Holy Book aloud, and also *Uncle Tom's Cabin* as it appeared serially.

"In fact," wrote Harvey Wiley in one of his numerous books, "father was the first conductor of the underground slave railway in our section."

Harvey adored his eldest brother James, who taught him to use a single-shovel plow, to hand-drop corn, to square the rows, and to handle horses in threshing grain by trampling under hoof. When James accidentally killed himself with a gun, Harvey was haunted by nightmares and would sometimes awaken screaming.

The boy's "green fingers" brought luscious growth to whatever he planted, even sorghum sugar cane. Seeds had been brought over from the Straits Settlement, Asia, in 1857, and a congressman had sent some to the elder Wiley, who passed them over to Harvey. He planted and nursed them tenderly and then made what was claimed to be the first sorghum syrup in this country. Neighbors smiled at the boy's delight over "starting a new industry," but it proved a boon to the area, for during the Civil War no molasses could come up the Mississippi from New Orleans.

Ruffle of war drums stirred the boy to high pitch and he joined up when Lincoln authorized the 100-day enlistments. He guarded Sherman's stores at Tullahoma, Tenn., and was praised for skillful withdrawal during a night attack. Discharged late in 1864, his big frame had shrunken from exposure and illness. He had had a severe case of measles. His first wobbly walk from the house was to tell his father that their idol, Abraham Lincoln, had perished under an assassin's bullet.

The family farm of 125 acres could produce little more than a bare living; so early in life the children were warned that those

who wanted education must work for it. All of them did. Harvey's health-breaking struggle was an inspiration to other boys. By living on potatoes, corn meal, and sorghum molasses, and toiling week-ends on the farm, he was able to attend Hanover College, from which he obtained his degree in 1867.

Then began a grueling schedule of teaching and study rarely matched. While teaching Greek and Latin at Northwestern Christian College, now Butler University, Indianapolis, Wiley obtained his medical degree at Indiana Medical College, and accepted the chemistry chair at the latter on condition that he might study at Harvard simultaneously.

He spent a total of five months at Harvard under the "boy president," Charles William Eliot, and then took seventeen days of oral and written examinations. He passed the tests for freshmen, sophomores, juniors, and seniors, and took his B.S. degree with the class of 1873. Incidentally, it was "cum laude."

Teaching at three institutions from early morning until late at night wrecked his great physique. He lay half dead for six months with cerebro-spinal meningitis, drove off physicians who sought to amputate a leg, and on arising became professor of chemistry at a new school, Purdue University, to whose later scientific fame be contributed much. Illness had removed his mop of black glistening hair.

In a tour of Europe, he attended the Paris world exhibition in 1878 with his eldest sister, Dr. Elizabeth Corbett, famed as one of the nation's first women physicians. Years later he was made a Chevalier of the Legion of Honor for drafting the French law on wine adulteration.

While still at Purdue, Wiley had become immersed in the relationship between chemistry, sugar, and agriculture. He visited factories, talked at meetings of sugar growers, lectured farm scientists at Washington, and finally accepted the invitation of Dr. George B. Loving, U. S. Commissioner of Agriculture, to become his Chief of the Division of Chemistry on April 9, 1883.

Now Harvey Wiley had indeed arrived. He had authority and facilities. At once he developed new apparatus and devised new testing procedures. His towering energy soon was concentrated on a study of the beet sugar problem—soil, rainfall, chemical reaction, and best growing areas. Before he had finished they called

him father of the beet sugar industry. But there were bigger things ahead.

His devotion to the Republican cause made him unpopular with Democrats. He inspired public confidence, however, and agriculture and science began heaping honors upon him. The American Chemical Society named him to the coveted post of president, and he nearly tripled the membership in a year. He presided at the first world congress of chemists in Chicago in 1892 and soon the story of his brilliance was being told throughout Europe.

Claims on his time multiplied as he broadened his far-flung research projects. He was induced to become professor of agricultural chemistry at George Washington University in 1899 and held the post fifteen years.

Politicians watched his power grow and began sniping at him for his outspoken references to rotten food and rotten medicines.

The food and drug trades reeked with outrageous practices. A typical patent medicine advertisement brazenly claimed the nostrum "cured" thirty-seven ailments, from asthma to ulcers. The public gagged down rivers of poisonous drugs that enriched the makers. It was estimated a total of 100 million dollars a year was being spent in patent medicine advertising around the turn of the century.

Food canners continued using harmful drugs to keep meat a bright red and vegetables a vivid green; milk was "embalmed" to retain freshness. Bills introduced in Congress to halt the death-dealing practices were killed amid laughter and ridicule.

One by one some powerful editors started moving over into the Wiley ranks. William Allen White began shouting in his *Emporia* (Kans.) *Gazette* against fraudulent advertising.

Wiley was encouraged to take a daring step toward shocking the public into action. With a fine sense of the dramatic he established, in 1902, the famous "poison squad" laboratory, the most highly advertised boarding house in history. He determined to prove on humans, not animals, the deleterious effects of doctored foods.

His call for volunteers brought twelve husky young men, mostly from government offices, who swore to eat only food prepared and served them by Dr. Wiley. Food was weighed; there

were daily physical examinations. Included in the diet were measured quantities of harmful food preservatives, ranging from boric acid to sulphate of copper. Each case history was minutely catalogued.

Wiley slaved like a madman; the press was delirious; and selfish interests howled dismally against the "murder of fine young men for science." Lew Dockstader, the minstrel, "laid them in the aisles" with his song on "cyanide of liver, arsenic fritters, and undertakers' pie."

But no one died, and Harvey had built a giant record of indisputable evidence. As reward he sat in the Senate gallery on February 21, 1906, and saw passage of the Pure Food and Drug Act which he had written, and which became law with President Theodore Roosevelt's signature on June 30, 1906. It was a monumental victory for the apostle of pure food, for agriculture, and for the American public.

But there were new breakers ahead. Powerful lobbies, aided by politicians, poured vindictiveness upon Wiley to prevent enforcement of the new law. Both President Roosevelt and Secretary of Agriculture James Wilson, Dr. Wiley charged, actually helped block enforcement.

As Wiley and his supporters interpreted the law, he had authority as chief of the Bureau of Chemistry to investigate food adulteration and to bring suit for law violation. But Secretary Wilson, Wiley charged, deliberately set up a three-man board of George P. McCabe, Dr. Frederick L. Dunlap, and Wiley, which effectively obstructed prosecutions. Always voting together, McCabe and Dunlap vetoed many key prosecutions that Wiley recommended. Food adulterators went merrily on their way. It was a rugged road for the battling Wiley, but a break finally came.

In 1911 there was a trumped-up charge that Wiley had overpaid a distinguished specialist, and George W. Wickersham, attorney general, ruled Wiley should be given a "condign punishment." A roar of public indignation brought a congressional investigation. Wiley was found guiltless. Moreover, the sly board set up to block law enforcement was promptly abolished.

Here at last was complete and joyful victory. The way had been definitely cleared for enforcement. So Wiley knew his great job had been done, and he resigned March 15, 1912. Typical head-

lines read: "Women Weep As Watchdog of Kitchen Quits After 29 Years."

In his crowded life Harvey Wiley had had few hours for social contact. But in 1898 he had fallen in love with a beautiful young librarian, Anna Campbell Kelton, and had carried her picture in his watch for the next ten years. She writes:

"In 1900, when he asked me to marry him (I was then twenty-three and he fifty-six) he seemed too old. Ten years later, all of which time we never met, we came together by chance. Soon we were engaged. He did not seem old to me then at all. After that life was never dull."

Wiley took his bride to Tennessee for the honeymoon—"to an important food trial."

A son was born and dubbed "the pure food baby." He was named John Wiley, but from public insistence the family changed his name to Harvey W. Wiley, Jr.; and a second son was named John Preston Wiley.

Harvey Wiley had become a hero to more than the housewives. When he left office Indiana Republicans wanted him for governor; seventy members of Congress petitioned him to run for Democratic vice-president. The Prohibition Party, elated by his fight on whisky adulterators, wanted him for president. Alluring commercial offers poured in; a liquor firm offered $125,000 a year.

Wiley's round, smooth face, with its narrow eyes and shaggy brows, wrinkled into a smile.

"I sort of thought I'd stay in this kind of work," he said, and immediately became associate editor of a national housekeeping magazine in which he stressed child welfare, health, and proper diet. He censored all advertising and set up standards by which the publication's "endorsement" of a product carried some weight.

Harvey Wiley died on June 30, 1930, four months after he had completed his autobiography, and twenty-four years to the day after enactment of his Pure Food and Drug law. They laid his tired body to rest in Arlington National Cemetery. He wore the little cap he had worn as a private in the Civil War. His tombstone bears the caduceus of the physician, a grain stalk for the farmer, and a scroll recognizing his service to "chemistry, agriculture, hygiene, and public welfare." Then there are these words:

"Father of the Pure Food Law."

GEORGE HARRISON SHULL

Creator of Hybrid Corn

GEORGE HARRISON SHULL

Born in Clark County, Ohio, April 15, 1874.

B.S., Antioch College, 1901.

Ph.D., University of Chicago, 1904.

Botany expert U. S. Bureau of Plant Industry, 1902-04.

Station for Experimental Evolution, Carnegie Institution, 1904-15.

Announced hybrid corn findings, January 28, 1908.

Professor of botany and genetics, Princeton University, 1915-42.

Awarded Gold Medal for invention of hybrid corn, November 30, 1940.

SONGS HAVE BEEN SUNG, POEMS WRITTEN, AND pictures painted in tribute to the American corn crop, for corn is the very backbone of agriculture, a true symbol of the nation's greatness.

Its culture is world wide, stretching from 58 degrees north latitude in Canada and Russia to 40 degrees south latitude in the southern hemisphere.

Yet in this country nearly three fourths of the world crop is produced, and the bulk of such out-turn is concentrated in the north central states, known as the Corn Belt.

It was in the Corn Belt that a bloodless revolution of economic significance began, after a pure scientist, delving into the mysteries of the origin of life, used the corn plant for his surprising experiments.

That scientist, George Harrison Shull, did a strange thing. He married corn to itself and, through its offspring, came up with an entirely new method of breeding, a method that led to the creation of hybrid corn. His singular discoveries made it possible to produce on the same number of acres a crop 25 per cent larger, a crop whose annual wealth now rates above that from our metal mines, or coal fields, or oil wells.

Mystery veils the origin of corn, or maize. In the entire exciting story of this plant there is no concrete evidence of how or where it started. It is the orphan of the fields, the "cry baby of crops." For endless centuries it has attached itself to man; it is incapable

of seeding itself because of its tight coverings, and it has never been known to grow wild.

On his first voyage to America, Columbus took note of the growth of the plant and referred to it as "corn," a word then meaning grain in general. He reported, some six years later, that there were Haitian cornfields stretching out a distance of eighteen miles.

It did not take long, after Columbus had returned to the continent, for corn-growing to spread from Spain to France, Italy, and Turkey, and later to many other lands, reaching China and Africa in the sixteenth century.

Nearly three centuries ago the Mayan civilization was centered around corn. Like the Incas and the Aztecs, the Mayans carved the glorious history of corn in stone and pictured it in pottery and expressed their gratitude for it in religious exercises and in tribal myths.

But English colonists on our eastern seaboard were first really to visualize the true worth of the plant. Corn actually saved the Jamestown and Massachusetts settlements during those first cruel winters when life hung in the balance. Later it became a medium of exchange, a form of money; and surplus corn built trade and commerce, and broadened the stream of immigrants crossing the Atlantic.

It was corn, too, that beckoned pioneers onward over wilderness trails opened by trappers and explorers, onward into the Middle West, where horses and oxen were not needed to clear land and uproot trees; one simply scratched the earth, planted corn, and in a few short weeks had an ample food supply. In these prairie states corn grew as it grew nowhere else, and as nothing else known to man would grow; its surpluses paid for cattle and hogs which were fed and fattened on corn and which multiplied.

As early as 1804, three years before the invention of the steamboat, George Renick built a herd of cattle on corn on his Ohio farm and drove them three hundred miles over the mountains to Baltimore with a loss of but a hundred pounds for each animal. He proved something. He proved that while it was too costly to move corn to the east, corn-fed livestock could be delivered profitably.

In less than two decades after Renick's herd had drifted lazily

over the rugged trail to Maryland, the Mississippi Valley had become the granary of the nation. Eastern states swung into industry and commerce with a new vigor, and looked to the West for food. And the West delivered. Most of the corn crop then, as today, was retained on the farm and converted into meat, poultry, and dairy products which flowed eastward in a widening stream.

Cornfields, in time, stretched from the Alleghenies to the Rockies and dotted every state in the Union. Famine has never touched America.

Long before Scientist Shull began tinkering with genetics and using corn as his experimental vehicle, thousands of other men—farmers and scientists—had struggled to improve culture and production. Even back in 1716 Cotton Mather, whose name is associated with witch hunting, reported observations of natural crossing of corn varieties.

"My friend planted a row of Indian corn that was colored red and blue," he wrote. "The rest of the field was planted with corn of yellow, which is the most usual color. To the windward side, this red and blue row so infected four whole rows as to communicate the same color unto them."

George Shull's background was agriculture. He was born April 15, 1874, on a hard-scrapple share-cropping farm near the village of North Hampton, Ohio, the son of a Dunkard minister who farmed all week and preached on Sunday and somehow provided for his seven children. Six of them were boys; all acquired education the hard way. Three of George's brothers became university professors, one a painter of scientific subjects, and a fifth the head of a group of Indiana high schools. There was no lure to share-cropping.

George Shull worked his way through Antioch College and the University of Chicago, where he received his degree of Doctor of Philosophy, and soon accepted a job at the newly organized Carnegie Institution Station for Experimental Evolution at Cold Spring Harbor, Long Island, New York.

It was in 1904 that he joined the genetics staff, engaged to probe into the mysteries of life's origin. As a farm boy he knew Indian corn is cross-bred in nature; soon he also knew that corn is the kind of plant you can breed to itself. On its tassels, high up,

it carries its sperm. Far down the stalk its eggs are concealed in the flowers of the young cob inside the ear shoot. He determined to marry maize to itself and see what happened, never dreaming what fortune would result to the nation.

In an experimental patch he put a bag over the tassels and another bag over the ear of corn itself, thus excluding fertilization from other corn in the field. When the right day arrived he took some of the pollen from the tassel and dusted it over the silk of the cob.

Nothing startling happened. The offspring were smaller but developed no pronounced defects.

"I'll marry them again," he said, and in the course of time the children appeared. They had all the characteristics of the parents, but still were smaller than their predecessors.

A fourth time Dr. Shull carried out the marriage ceremony, and then once again; and finally he gazed in astonishment upon the offspring... athletic offspring as vigorous as wrestlers. He knew he had something.

What Shull actually did, and what many corn breeders after him did, was to inbreed certain selected lines for four or five generations. Peculiar characteristics were thus intensified. Seed of these inbreds were not nearly so prolific as other cross-pollinated varieties. But fertility of seed was not sought. Interest centered in intensifying the hereditary characteristics of chosen strains. When, after four or five generations, two inbred strains were crossed, the seed had immense vitality.

Dr. Shull kept on making discoveries as he pursued the work year after year. By 1908 he felt he had something to say and on January 28 he said it in an address at Washington, D. C. before the American Breeders Association. In precise scientific language he related his revolutionary findings. Everyone listened politely, but no one became the least bit excited as the quiet scientist, with the cropped beard and pleasant smile, unfolded his tale.

After all, some one remarked when the meeting had closed, there were other corn breeders. What of E. M. East, W. J. Beal, J. L. Reid, A. E. Blount, and R. A. Emerson? Indeed, a technique of breeding hybrid seed corn had been developed in 1905 at the University of Illinois by A. D. Shamel. Maybe Shull had something and maybe he didn't.

Shull kept his smile as he shook a few hands before returning to his laboratory at Cold Spring Harbor. But he wasn't through talking. He popped up again the next year before the very same group of tall-browed scientists, and presented what is now regarded as his most significant paper.

He did, in fact, commented the *Seed World* thirty-three years later, present at that meeting a procedure for production which was practical and "which is in all its essentials the basic method now used in developing hybrid corn seed."

Energetic Professor Shull still was not convinced that his methods were thoroughly understood, and so once more, at the Breeders' next annual meeting in Omaha he reviewed the record; and then people began to think and talk, and research activity was revivified on a hundred fronts. The hybrid idea crept with insidious stealth into the consciousness of some Middle West corn growers. It had to move slowly, of necessity, because of the staggering amount of work involved.

Hybrid corn has been compared to the mule, which is a first-generation hybrid between the mare and the ass. It picks up the better qualities of both parents. But it cannot reproduce. A corn hybrid is the first-generation hybrid between two strains of corn; its value is for seed in the heavier production of commercial corn. This corn will grow in abundance, but it cannot be used for seed without a loss in yield. It must be produced anew each year.

Before the Shull theory became understood and accepted, corn had been self-fertilized very rarely by the experimenters. In fact many authorities believed that corn was self-sterile. But at length the creation of hybrid corn became the chief interest of most of the agricultural experiment stations. World War I held back the development while farmers sought mass production.

But a few years after the war had ended, hybrid corn began appearing on the market for commercial sale and the revolution in corn-growing methods was under way.

Shull's discoveries were given government recognition and were characterized by a Department of Agriculture official as perhaps "the most outstanding example of theoretical scientific research in revolutionizing production practice."

Farmers are not given to quick change. For generations they had done very well indeed by the simple method of choosing for

seed the most likely appearing ears in their corn fields. But when they began to see mile-long rows of tall, strong-stemmed plants, strikingly uniform in shape and color, having little in common with their scrubby, small-eared ancestors, they visualized a new wealth within easy grasp.

In the deep valley of farm depression in the early 1930's the systematic hybridization of corn began in earnest. The idea was expanded commercially and hybrid seed became available in steadily increasing volume. By 1943 hybrid seed had added an estimated 669,000,000 bushels to the corn crop, or the equivalent of one fourth, based on pre-hybrid years.

Corn production reached new peaks in World War II, and touched a dizzy all-time top of 3,649,510 bushels in 1948 when America was trying to feed the hungry millions of the old world. And the acreage planted to hybrid seed in 1946 was 67.5 per cent of the total in the entire country, and 97 per cent of the total in the Corn Belt.

Today commercial production of hybrid corn seed is big business. Besides a half dozen large producing firms, there are scores of small producers, reaching down to individual farmers who annually follow the chart of Scientist Shull. On the big commercial hybrid farms large staffs are required in season. Through vast fields one may see boys and girls riding along on tractor-drawn scaffolds detasseling certain rows in preparation of proper marriage.

Today no other single agricultural crop makes up so large a part of the American diet, directly or indirectly, in the form of meat, milk and eggs. Whether you eat at home, at the club, or at Joe's lunch wagon you are getting products of corn for breakfast, lunch, and dinner.

But corn's versatility extends far beyond its primary use as food and feed. It passes into an amazingly long list of industrial products; it is turned to many medical uses, ranging from penicillin and sulfa tablets to lactic acid, used as shock preventive in cases of bad burns.

Dollar value of the corn crop equals that of the cotton, wheat, and oats crops combined.

Dr. Shull left the Station for Experimental Evolution in 1915 to become professor of botany and genetics at Princeton Uni-

versity. In 1942 he became professor emeritus, and still makes his home in Princeton, New Jersey, with his wife, the former Mary J. Nicholl. His six children come from scattered points for holiday reunions.

Smiling, quiet, and modest, Dr. Shull is always quick to heap praise on others for the great achievement with which he is credited.

At a banquet in his honor in Chicago on November 30, 1940, he was awarded a gold medal by the DeKalb Agricultural Association for "the invention of hybrid corn."

Said the toastmaster: "Dr. Shull's contribution to agriculture is probably the most outstanding in our time."

Said Scientist Shull: "My dreams came true long after they had faded."

AND THESE, TOO, SERVED

Abraham Lincoln
Horace Greeley
Luther Burbank
David Fairchild
Liberty Hyde Bailey
Cyril George Hopkins
The Cokers
Henry Ford
George Washington Carver

LET IT NOT BE IMPLIED THAT OUR AGRICULtural empire was built by any small group of men.

It was built by generations of farmers—millions of hard-fisted, freedom-loving individualists who applied toil and sweat and ingenuity to the task.

But in this task they were assisted immeasurably by the notable contributions of thousands of men—chemists, agronomists, biologists, breeders, plant explorers, inventors, and legislators. Some of these benefactors of agriculture merit special mention here, including Abraham Lincoln.

It is understandable that an occasional historian, whose admiration for Lincoln stopped just this side of idolatry, should have over-emphasized his gifts to agriculture. The truth is that his assistance was substantial, especially in a legislative way; yet it was small when compared, for example, to that of Washington or Jefferson.

Lincoln never was a farmer, never engaged in any form of soil culture. The famed log cabin in which he was born rested on a tract of thin soil in the wilderness of Hardin County, Kentucky, and he spent his early boyhood on a near-by plot of thirty acres, fourteen of which were tilled by his father. When young Lincoln was seven years old the family moved to a wooded section of southern Indiana, where the elder Lincoln hunted, did carpenter work, and planted a little grain, and where Lincoln as a youth split rails and helped clear timber land.

By the time he had come of age the family had moved along

to Illinois. Lincoln was quick to identify himself with "city life" at New Salem, clerking in a store, managing a mill, becoming postmaster, and working at various other jobs.

His study of law was eager and intense and fastened his interest above all else; and the practice of law led naturally to politics as a career, for he made deep and enduring friendships. His devotion to the cause of the common man was genuine and without guile and mirrored a candor and sincerity that inspired confidence.

Such confidence broadened during his seven years of service in the state legislature, beginning in 1834. He never forgot that he represented a farming community in a frontier area, and he fought constantly for better roads and canals.

It is true that Lincoln uttered no profound thoughts that might revolutionize agriculture; but it is equally true that as his career unfolded he was increasingly sensitive to farmer needs and labored diligently on progressive measures. In his most comprehensive talk on agriculture, at Milwaukee on September 30, 1859, while campaigning for the presidency, he said:

"Farmers, being the most numerous class, it follows that their interest is the largest interest. It also follows that that interest is most worthy of all to be cherished and cultivated—that if there be inevitable conflict between that interest and any other, that other should yield."

He favored use of machinery and introduction of the steam plow, at the same time recognizing the practical difficulties of maintaining such equipment in frontier communities. He vigorously opposed the so-called "mud-sill" theory that farmers should be denied educational advantages.

"This leads to the further reflection," he continued, "that no other human occupation opens so wide a field for profitable and agreeable combination of labor with cultivated thought, as agriculture."

Lincoln knew nothing so pleasant to the mind as the discovery of something "that is at once new and valuable—nothing that so lightens and sweetens toil, as the hopeful pursuit of such discovery. And how vast, and how varied a field is agriculture."

He knew the minds and the hearts of the farmers, knew what to say and how to say it, and with this address he became the political spearhead of midwestern and other frontier farmers.

He again stressed the pre-eminence of agriculture from the standpoint of national interest in his first presidential message to Congress. Despite its size, agriculture, in its independence, had not "demanded and extorted more from the government," and, he added, it merited consideration, at least to the extent of a statistical bureau.

It was soon thereafter that agriculture was lifted from its place as a division of the Patent Office to the status of a department, a symbol of the rising dignity of the farmer.

In the matter of the homestead law, Lincoln favored "cutting up the wild lands into parcels so that every poor man may have a home."

He did not beat the drum for land grants to agricultural colleges, but he did, nevertheless, give sturdy support to the Morrill Act containing such provisions.

And within a period of seven weeks in 1862 Lincoln happily penned his signature to three statutes of towering significance to American agriculture: the bill creating the Department of Agriculture, the homestead act, and the land grant college act. In so doing he revealed a constancy to agriculture not apparent on the part of his predecessor in the White House.

This, then, was the tangible support to agriculture made by the martyred President who captained a nation in its battle for free soil and free men.

Two years to the month after Lincoln's birth, another great battler for agriculture, Horace Greeley, was born in a rickety unpainted house on a desolate farm in New Hampshire, February 3, 1811. Third of a family of seven children, he was so feeble he was expected to follow the two elder children into an early grave, but his remarkable mother nursed him to health and started him to school at three.

Hopelessly sunk in debt, Greeley's father one day gathered the family together and fled to Vermont to avoid jail for bankruptcy. By odd jobs, gathering firewood and nuts and working on farms, young Horace added his pennies to the family budget, while leading his classes at school.

Even as a youth he had an astonishing "feel" of public sentiment, and his voracious reading added to his political adroitness.

This was given full play in New York, where he went in quest of his fortune and where, at the age of thirty, he founded the *New York Tribune.* Through this organ for thirty years he thundered his doctrine of political and economic freedom for all men. He harped on free distribution of public lands to those who would cultivate them.

Greeley obtained a seat in Congress for three months in 1848 and immediately introduced a homestead bill which became a political football to be kicked about unmercifully; but the editor bellowed the glories of such legislation and the people listened and lifted voices in support.

"Soundness of the principle is not questioned by adversaries," Greeley wrote. "They have a safer method of warfare. No bill can be drawn so as to hit their several tastes."

Space was tight on the *Tribune,* May 21, 1862, the day after Lincoln signed the measure as finally enacted. On page one was a map showing Union General McClellan only ten miles from Richmond, and the death of the famous Irish comedian John Drew was squeezed into a bare eight lines. But Horace Greeley found space to print the entire homestead bill as enacted, and to editorialize:

"Hereafter any man with a month's wages in his pocket can enter into possession of a farm of his own... a home for himself and his children. Free homes are secure; now let us have free men and free labor to complete the legacy we ought to leave the generations that are to come."

His terrific drive for the homestead act was supplemented by campaigns in behalf of innumerable solid projects aimed at more abundant crops with less back-breaking toil. His daily, semi-weekly, and weekly issues, with a combined circulation of nearly 300,000 when the Civil War broke out, carried columns of weather and crop news, and long letters on improved farming methods. He himself took the platform for agriculture and was a popular speaker.

On his farm at Chappaqua, New York, Greeley carried out a series of crop experiments and reclamation work, and progress reports in his news columns held national interest. In his comprehensive book, *What I Know of Farming,* he covered a broad range of subjects. He dedicated the book to the first man "who shall

make the first plow propelled by steam, or other mechanical power, whereby not less than ten acres per day shall be thoroughly pulverized to a depth of two feet, at a cost of not more than two dollars per acre."

Greeley was widely caricatured, with his white hat, white coat, white socks, and bushy neck whiskers, at the peak of his political career, a career that ended disastrously after his futile campaign for President against General Grant in 1872. The strain was too much; Mrs. Greeley died, and Greeley's death also came a few weeks after Grant's election.

By use of his great influence in the interest of the small farmer, and by reason of his broad understanding of farm problems, Greeley performed a genuine service and gave substance to his famous slogan:

"Go West, young man."

One young man who went west from his native Boston was Luther Burbank, thirteenth child of a farmer and pottery maker. He had been given a sound education and the privilege of indulging his love of flowers, plants, and farm produce.

When Burbank was twenty-one years old in 1870 he began producing pre-season fruits and vegetables by a forced-growth method. It was inspired by having observed a glen, fed by a warm spring, that remained green and verdant in winter months. At the Fitchburg market his competition caused consternation among seasoned producers.

He tackled the small, reddish, poor-keeping New England potato, seeking, without success, a sturdy strain through cross-fertilization. His victory came, however, when he found a rare potato seed-ball with twenty-three seeds. "It was with the Burbank potato," he later wrote, "that I made my beginning as a plant developer."

He sold out his business and went to Santa Rosa, California, taking along ten of the famous Burbank potatoes. For the next half century, until his death in 1926, he toiled at making nature give man better foods, prettier and more fragrant flowers, more useful trees, sturdier grains and grasses. His streamlining of nature permitted high commercialization of the nursery business. He is credited with creating more than twenty-five hundred dis-

tinct species of plants. Remarkable was his work in lifting the plum from a small, tart local fruit to a luscious product that could be shipped long distances into channels of consumption.

Imaginative and forward-looking, Burbank sifted and tested plants from all corners of the globe. He was too busy to keep scientific records. This may account, in part, for the fact that many leading scientists are inclined to lift a brow when Burbank's work is evaluated.

"At times," wrote David Fairchild, former Department of Agriculture plant explorer, "I have criticised Burbank for allowing those around him to grossly exaggerate claims of his new creations.... However, Burbank grew up as a commercial nurseryman and spent his life in an atmosphere where plants meant money....

"On the other hand, had Burbank's large-scale methods of plant selection been emulated more widely, I believe that the orchards of this country would have many more fine varieties today."

Fairchild should know, for he criss-crossed the globe in quest of new plants more than any other man. Born in Michigan in 1869, descendant of a family of educators, he received his degree at Kansas State Agricultural College, of which his father was head, and at twenty-four began his world travels. Many of his distant trips were financed by the wealthy Barbour Lathrop.

From South America, the South Pacific, Russia, and the Orient Fairchild sent back plants to be recorded in a card file with the precision of a finger-print record.

Peru contributed an alfalfa that now grows in Southern California; Chile, a hardy avocado; Argentina, new trees for Florida and California, and a spineless cactus that cattle eat on the desert, a cactus, incidentally, which Burbank had sought by grafting.

From almost unheard-of points Fairchild sent a stream of trees, grass, grain, grapes, and shrubs. Egypt was similar in growing conditions to the Rio Grande and the Colorado River regions; so he sent home lettuce, peanuts, okra, vegetable marrow, pumpkins, onions, cotton, and clover.

Not everything succeeded in new climates. And some things were slow to please the American palate: avocado, broccoli, pomegranates, dates, mangos, udo, and bamboo. But on the

whole Fairchild's mass importation of thousands of types and varieties was an innovation of immense good.

Soon after his marriage to the daughter of Alexander Graham Bell in 1905, Fairchild settled in Washington as head of the Foreign Plant Exploration Division. He sent explorers throughout the world; his domestic staff distributed forty thousand plants to farmers.

Fairchild takes greatest pride in the beauty he has added to the country: shade trees, Japanese cherry trees, roses, tropical flowering vines, and the like. These are, of course, insignificant compared with the great economic value of his work.

Like other plant explorers and scientists, Fairchild holds in highest esteem the writing and teaching of Liberty Hyde Bailey, a native of Michigan, who was born and reared on a farm. At twenty-seven, in 1885, he became professor of horticulture at Michigan Agricultural College, served in the same post at Cornell for five years, and then for a decade was dean of agriculture at Cornell.

By his voluminous writings, as well as by his teaching, Bailey is credited with contributing as much as any other man to the building of our modern horticulture. He began popularizing the subject sixty years ago with his *Talks Afield,* and in the interim edited two score books, in addition to his own huge output.

Scientists termed his efforts "herculean." He urged horticultural departments in colleges, fought for forest conservation, and stimulated plant selection and breeding. Honors have been heaped upon him for his scientific works on berries and palm trees. The "Grand Old Man of Horticulture" was still living in Ithaca, New York, in 1948.

While Bailey wrote on horticulture, another native midwesterner was making history with his soil fertility research. Cyril George Hopkins, born on a primitive Minnesota farm, was educated in agriculture in North Dakota, and in chemistry at Cornell and Göttingen, Germany.

Hopkins undertook the staggering task of surveying the soil of the entire state of Illinois soon after he joined the University of Illinois staff in 1900 at the age of thirty-four. Up to that time

knowledge of soil fertility was based principally on the work of the Rothamsted experimental station in England.

Under the "Illinois System," as the Hopkins method became known, there were set forth six factors in plant growth: seed, temperature, moisture, light, a home for the plant, and food for the plant.

Food for the plant is what Hopkins sought, and this he reduced to ten major elements: plants got carbon, hydrogen, and oxygen from the air and rain; iron and sulfur were ample in most soils and atmospheres. Hence these five elements accounted for 96 per cent of the plant needs. It was, therefore, calcium, magnesium, potassium, nitrogen, and phosphorus that presented the problem. And that problem varied in each locality.

But Hopkins won his battle. In time he was able to set up a system under which each farmer could have his own soil chemically analysed, with free advice on how to improve fertility. The more erosion, the more vigorously Hopkins fought for, and aided, soil conservation.

To clinch his point, he bought a desolate spot which he named Poorland Farm, a barren stretch defying vegetation. In a decade he was harvesting thirty-five bushels of wheat to the acre. This led to his book, *Bread From Stones.*

Greece awarded Dr. Hopkins the Order of Our Savior for his remarkable soil work for that country. While returning homeward he developed malaria and died at Gibraltar, at the age of fifty-three.

By his vast research Hopkins had left his mark on the land.

The distinguished Coker family of South Carolina—agriculturists, scientists, educators, bankers, and industrialists—has contributed abundantly to Southern agricultural progress.

Founder of the family in America, Thomas Coker, a man of exceptional physical and mental power, came from England to Virginia and then in about 1735 moved along to South Carolina, where he set a pattern for his descendants.

A great-grandson, James Lide Coker, who was born on a plantation near Society Hill, South Carolina, January 3, 1837, studied soil analysis and plant development at Harvard under Louis Agassiz and Asa Gray before taking over a large estate near

Hartsville. At once he launched an agricultural society for development and distribution of scientific facts. His immediate dreams were shattered by the Civil War. In that conflict Major Coker was wounded and captured, and later returned to a ruined and bankrupt plantation. With marked genius he built his lands and his various business projects into one of the biggest fortunes in South Carolina history. Coker College was an outgrowth of one of his many philanthropies.

He and his son, James L. Coker, Jr., manufactured wood pulp on a practical scale from the pine so common in the section. From paper they made the cones and parallel tubes used in yarn mills; they launched cotton and cottonseed mills and operated a bank and built a small railroad.

With another son, David Robert Coker, the father developed on his farm one of the South's principal agencies for seed testing and plant development. After the father's death in 1918, David Coker carried on this work with singular intensity until his own death in 1938 at the age of sixty-eight.

Many of David Coker's achievements had been but distant hopes of his father. He created new varieties of cotton and corn, a high-yielding type of wheat, a smut- and cold-resisting type of oats, a new yam type of potato, and a superior type of cigarette tobacco. His cotton studies resulted in better yield and quality and longer staple in the Southeast and Mississippi Valley.

His single aim was to help the Southern farmer through science. He delved deeply into basic problems—fertilizer for specific soils, seeding rates, weevil control, and a balance of food and feed crops for the individual farmer over and above the money crop. His fame spread far and wide, and to his experiment station yearly came a steady stream of farmers and government officials, agronomists, chemists, and plant breeders, seeking advice and guidance.

Another illustrious son of James Lide Coker is the internationally famous botanist, Dr. William Chambers Coker, whose many books, scientific papers, and lectures based on domestic and foreign research have brought renown in the scientific world. In his brilliant studies on vegetation, plant life, and trees he is credited with original thinking that has redounded to the benefit not only of this country but to several foreign lands as well. Among his

numerous posts he is the director of the Coker Arboretum in Chapel Hill, North Carolina, and a Kenan Research Professor Emeritus of Botany at the University of North Carolina.

Robert Ervin Coker, son of William Caleb Coker, and Kenan Professor of Zoology at the University of North Carolina, also deserves mention here because of his many years of distinguished work on marine fisheries investigations and his present active chairmanship of the Institute of Fisheries Research, a North Carolina project established in 1947 to develop the intelligent use of a great natural resource both for food and for industry.

Among the great industrialists who have assisted in the enlargement of agriculture was Henry Ford. He was particularly influential in fostering closer relationship between agriculture and industry. He was an apostle of chemurgy, that branch of chemistry devoted to the use of farm products for industrial purposes. He practiced chemurgy in his enormous automobile plants, applying plastic parts made of soybeans and other farm products where practicable.

He was frequently given exaggerated credit in connection with development of the now huge soybean industry. Historians will some day pay proper tribute to William J. Morse of the Bureau of Plant Industry who as an explorer brought ten thousand types and varieties of soybeans into the country, and who in the past forty years has written scores of government bulletins and made innumerable inspiring addresses before research experts, plant scientists and growers.

Ford's service to agriculture was nevertheless substantial, aside from providing a sturdy low-cost car to farmers. The motor genius spent millions promoting mechanized agriculture, and his small tractor gave forceful incentive to such development.

In the field of chemurgy, there were others who pre-dated Ford. When Lincoln freed the Negroes he opened the way for the fascinating career of George Washington Carver.

Carver was born in slavery. One dark night in the third year of the Civil War, sheeted horsemen raided the plantation of Moses Carver, in the far southwest corner of Missouri, and dragged his slaves through the mud into Arkansas. Among the captives was a

Negro mother, clutching to her the bony frame of a baby boy. Planter Carver dispatched an agent to ransom his slaves; the mother had disappeared but the agent traded a race horse for the ailing baby, who became the greatest Negro scientist in history. Many race-proud Southern whites came to recognize the great value of his contribution to Southern life.

So appealingly honest was the little boy that the planter named him George Washington Carver. With many a heartache, Carver worked his way through high school and college before beginning his long career at Tuskegee Institute, famed Negro school in Alabama.

If not the greatest chemurgist, Carver certainly was first to put the science of chemurgy to work. From his discoveries huge businesses were built; particularly did he vastly enlarge the peanut industry and put fortunes into the pockets of Southern farmers. His peanut experiments led to the creation of some 300 edible and industrial uses, ranging from butter and flour to soap and fertilizer.

Carver was a tireless exponent of the use of idle lands for greater crop diversification.

His work with the sweet potato lifted it to a Southern farm staple.

But from the standpoint of human welfare his direct achievement was in teaching poor Negroes and whites how to grow at their own homes nutritious foods, how to cook them, and how to effect a balanced diet. Thus he lightened the scourge of pellagra.

Huge salary offers from corporations were always quietly rejected. Carver was that rare soul who was interested only in helping his fellow man. What money came his way was put back into his work.

The kindly little "doctor" of the tattered old clothes and patched-up shoes died on January 5, 1943. He died without a red cent to his name.

PRELUDE TO FUTURE

WHEN AMERICA WON INDEPENDENCE AS A NATION, every phase of its democracy was obnoxious to rulers of the Old World. Many of them set about to defame and discredit the new nation and its leaders. Like some rulers of today, they detested free government, human rights, personal initiative, and the eternal principles of justice—indeed, all the basic factors essential to the upbuilding of a sturdy race and nation.

Against such odds, against wilderness handicaps, even against division in its own house, America touched pinnacles of power never elsewhere attained in the long stream of human history.

And from the very beginning agriculture was the life-blood of the nation, and so it is today, and so it shall be in generations to come.

In the past decade pessimists have been heard to say there are no more frontiers in agriculture. Such talk is the talk of men with tired and unimaginative minds. It is the same bleak philosophy of those Spanish explorers who gazed at the mouth of the St. Lawrence River and named our great neighbor to the north Acanada ... "Here is nothing."

Today in hundreds of laboratories across the land, in test fields, in orchards, in experimental coops and pens and pastures, brilliant men of science, in numbers never before approached, are solving mysteries and piercing frontiers. As certainly as day dawns, they will add new magic to agriculture. The chemurgic use of farm products in plant and factory will add new magic to industry, all to the betterment of man.

And so agriculture's past is, indeed, but a prelude to its future.

REFERENCES

GEORGE WASHINGTON

Brooke, W. E., ed. *The Agricultural Papers of George Washington.* Boston, R. G. Badger, 1919.

Edwards, E. E. *George Washington and Agriculture.* Washington, D.C., Department of Agriculture, 1936.

Eyre, Louisa Lear, ed. *Letters and Recollections of George Washington.* New York, Doubleday, Page and Company, 1906.

Fitzpatrick, J. C., ed. *The Diaries of George Washington.* 4 vols. Boston, Houghton Mifflin Company, 1925.

Fitzpatrick, J. C., ed. *The Writings of George Washington.... Prepared under the Direction of the U. S. George Washington Bicentennial Commission.* Washington, D. C., Government Printing Office, 1931-.

Haworth, P. L. *George Washington, Farmer.* Indianapolis, Bobbs-Merrill Company, 1915. (Republished as *George Washington, Country Gentleman,* 1925.)

Hughes, Rupert. *George Washington.* New York, William Morrow and Company, 1926.

Ritter, H. L. *Washington as a Business Man.* New York, Sears Publishing Company, 1931.

Toner, J. M. *George Washington as an Inventor and Promoter of the Useful Arts.* Washington, D. C., Gedney and Roberts Company, 1892.

Wilstach, Paul. *Mount Vernon, Washington's Home and the Nation's Shrine.* Garden City, Doubleday, Page and Company, 1916.

Thomas Jefferson

Adams, James Truslow. *The Living Jefferson.* New York, Charles Scribner's Sons, 1936.

Beard, Charles A. *Economic Origins of Jeffersonian Democracy.* New York, The Macmillan Company, 1915.

Browne, Charles A. *Thomas Jefferson and the Scientific Trends of His Time.* Waltham, Massachusetts, The Chronica Botanica Company, 1943.

Edwards, Everett E., ed. *Jefferson and Agriculture.* Washington, D. C., Department of Agriculture, 1943.

Hirst, Francis W. *Life and Letters of Thomas Jefferson.* New York, The Macmillan Company, 1926.

Honeywell, Roy J. *The Educational Work of Thomas Jefferson.* Cambridge, Harvard University Press, 1931.

Miller, August C., Jr. "Jefferson as an Agriculturist," *Agricultural History,* XVI, 65-78.

Russell, Phillips. *Harvesters.* New York, Brentano's, 1932.

Thomas Jefferson's Garden Book. American Philosophical Society, Proceedings, 1936.

Ward, James E. "Jefferson's Contributions to Agriculture," *University of Virginia News Letter,* April 15, 1943.

Wilson, M. L. *Jefferson, Father of Agricultural Science.* Washington, D. C., Department of Agriculture, 1943.

Elkanah Watson

Deane, Wm. R. *A Biographical Sketch of Elkanah Watson.* Albany, New York, J. Munsell, 1864.

Neely, Wayne Caldwell. *The Agricultural Fair.* New York, Columbia University Press, 1935.

Pound, Arthur. *Native Stock.* New York, The Macmillan Company, 1931.

Watson, Elkanah. *A Tour in Holland in MDCCLXXXIV by an American.* Printed by Isaiah Thomas at Worcester, Massachusetts, 1790.

Watson, Winslow, ed. *Men and Times of the Revolution; or, Memoirs of Elkanah Watson,* edited by his son. New York, Dana and Company, 1856.

Eli Whitney

Bates, Edward Craig. "Story of the Cotton Gin," *New England Magazine,* May, 1890. *Connecticut Journal* (New Haven), January 11, 1825.

Dexter, F. B. *Biographical Sketches of Graduates of Yale College,* Vol. V.

Hammond, Matthew Brown. "Correspondence of Eli Whitney Relative to Invention," *American Historical Review,* October, 1897.

Lewton, F. L. *Historical Notes on the Cotton Gin.* Annual Report of the Smithsonian Institution. Washington, D. C., 1937.

Mitman, Carl W. "Eli Whitney." *Dictionary of American Biography,* XX, 157-60.

Olmsted, Denison. "Memoir of Eli Whitney, Esq.," *American Journal of Science and Arts,* January, 1832.

Papers of New Haven Historical Society, Vol. V, 1894.

Patterson, John C. *America's Greatest Inventors.* New York, Thomas Y. Crowell Company, 1943.

Scarborough, William. "Sketch of Life of Late Eli Whitney," *Southern Agriculturist,* August, 1832.

Henry Leavitt Ellsworth

Barnett, Claribel R. "Henry Leavitt Ellsworth." *Dictionary of American Biography,* VI, 111.

Brief History of the U. S. Patent Office from Its Foundation 1790 to 1886. Washington, D. C., R. Beresford, printer, 1886.

Brown, William Garrott. *Life of Oliver Ellsworth.* New York, The Macmillan Company, 1905.

Daily National Intelligencer. Washington, D. C., March 4-15, 1839.

Ellsworth, Henry Leavitt. *A Digest of Patents Issued by the United States from 1790 to Jan. 1, 1839.* Washington, D. C., published by Act of Congress, printed by Peter Force, 1840.

Ellsworth, Henry Leavitt. *Improvements in Agriculture and the Arts of the United States.* Published by the *New York Tribune,* Greeley and McElrath, 1843.

Irving, Washington. *A Tour on the Prairies* (1835). The Jenson Society (printed for members only), 1907.

Journal of the Patent Office Society, Vol. I, no. 1. Washington, D. C., September, 1918.

Journal of the Patent Office Society, Vol. XVIII, no. 1. Washington, D. C., January, 1936.

Kaempffert, Waldemar, ed. *A Popular History of American Invention.* New York, A. L. Burt, 1924.

Keiper, Frank. *Pioneer Inventions and Pioneer Patents.* Rochester, New York, 1923.

Learned, Henry Barrett. *The President's Cabinet.* New Haven, Yale University Press, 1912.

Swank, James Moore. *Department of Agriculture, Its History and Objects.* Washington, D. C., Government Printing Office, 1872.

Vaughan, Floyd L. *Economics of Our Patent System.* New York, The Macmillan Company, 1925.

Edmund Ruffin

Craven, Avery. *Edmund Ruffin, Southerner.* New York, D. Appleton and Company, 1932.

Cutter, W. P. "A Pioneer in Agricultural Science," *Yearbook of the U. S. Department of Agriculture, 1895.* Washington, D. C., Government Printing Office, 1896.

Daily National Intelligencer. Washington, D. C., June 22, 1865.

Demaree, Albert Lowther. *American Agricultural Press 1819-1860.* New York, Columbia University Press, 1941.

Gray, Lewis Cecil. *History of Agriculture in the Southern United States to 1860.* Carnegie Institution of Washington. New York, Peter Smith, 1941. 2 vols.

Hamilton, J. G. de Roulhac. *The Papers of Thomas Ruffin.* Raleigh, North Carolina, Edwards and Broughton Printing Company, State Printers, 1918-20. 4 vols.

Richmond Daily Times, June 20, 1865.

Ruffin, Edmund. *An Address on the Opposite Results of Exhausting and Fertilizing Systems of Agriculture.* Charleston, South Carolina, Steam Power Press of Walker and James, 1853.

Ruffin, Edmund. *African Colonization Unveiled.* Washington, D. C., Lemuel Towers, 1858-59.

Ruffin, Edmund. *Agricultural Survey of South Carolina* for 1843. Columbia, South Carolina, the first 32 pages by A. H. Pemberton, the rest by Dubose and Johnston, 1843.

Ruffin, Edmund. *Communications on Drainage.* Richmond, Virginia, Virginia State Agricultural Society, 1857.

Ruffin, Edmund. *Essay on Calcareous Manures.* Petersburg, Virginia, printed for the author, 1842. Third edition.

Ruffin, Edmund. *Essays and Notes on Agriculture.* Richmond, Virginia, J. W. Randolph, 1855.

Ruffin, Edmund. *Management of Wheat Harvest.* Report of the Commissioner of Patents for the year 1850, part II. Washington, D. C., Office of Printers to House of Representatives, 1851.

Ruffin, Edmund. *Premium Essay on Agricultural Education.* Richmond, Virginia, J. W. Randolph, 1853. Second edition.

Ruffin, Edmund. *Sketches of Lower North Carolina.* Raleigh, North Carolina, printed at Institute for the Deaf and Dumb and the Blind, 1861.

Swem, Earl G. "An Analysis of Ruffin's Farmers' Register," *Bulletin of the Virginia State Library.* Richmond, Virginia, Davis Bottom, 1919.

John Deere

Aldrich, Darragh. *The Story of John Deere.* Minneapolis, McGill Lithograph Company, 1942.

Clark, Neil M. *John Deere.* Moline, Illinois, printed privately by Desaulniers and Company, 1937.

Deere, John, and Company. *The Operation, Care, and Repair of Farm Machinery.* Moline, Illinois, printed by Desaulniers and Company, 1941. Fifteenth edition.

Handy Farm Account Book, The. Moline, Illinois, issued by John Deere, 1930.

Moline (Illinois) *Dispatch.* Miscellaneous articles.

Story of John Deere, The. Moline, Illinois, brochure published at John Deere Centennial, 1937.

Taylor, Dr. W. E., Director Soil Culture Department, Deere and Company. *Better Hay—How to Make and Market It.* Moline, Illinois, 1918.

Cyrus Hall McCormick

Casson, Herbert N. *Cyrus Hall McCormick, His Life and Work.* Chicago, A. C. McClurg and Company, 1909.

Casson, Herbert N. *Romance of the Reaper.* New York, Doubleday, Page and Company, 1908.

Gaines, Dr. Francis Pendleton (excerpts from address April 18, 1933) and Gore, Professor James H. *Cyrus Hall McCormick.* Washington, D. C., printed by James H. Gore, 1935.

Hutchinson, William T. *Cyrus Hall McCormick (Harvest, 1856-1884).* New York, D. Appleton-Century Company, 1935.

Hutchinson, William T. *Cyrus Hall McCormick (Seed-Time, 1809-1856).* New York, The Century Company, 1930.

MacDonald, William. *Makers of Modern Agriculture.* London, Macmillan and Company, Limited, 1913.

McCormick, Cyrus. *The Century of the Reaper.* Boston, Houghton Mifflin Company, 1931.

McCormick Day at V. P. I. Bulletin of Virginia Agricultural and Mechanical College and Polytechnic Institute, Vol. XXV, no. 6. Blacksburg, Virginia, 1932.

Miscellaneous material at McCormick Historical Association Library, Chicago.

The Reaper: Argument of William H. Seward in Circuit Court of the U. S. Albany, New York, October 24, 1854.

Thwaites, Reuben G. *Cyrus Hall McCormick and the Reaper.* Madison, Wisconsin, State Historical Society, 1909.

Justin Smith Morrill

Andrews, Benjamin F., Bureau of Education, Department of the Interior. *The Land Grant of 1862 and the Land-Grant Colleges.* Washington, D. C., Government Printing Office, 1918.

Federal Government Funds for Education, 1944-45 and 1945-46. Washington, D. C., Government Printing Office, 1946. Leaflet no. 77.

Fuess, Claude M. and Blackmer, Alan Rogers. "Justin Smith Morrill," *Dictionary of American Biography,* XIII.

Justin Smith Morrill. Centenary Exercises Celebrated by the State of Vermont, at Montpelier, April 14, 1910, in Honor of Justin Smith Morrill. Fulton, New York, Morrill Press, 1910.

Knight, George W. "History and Management of Land Grants for Education in the Northwest Territory," *Papers of the American Historical Society,* Vol. I, no. 3. New York, G. P. Putnam's Sons, 1885.

Lamb's Biographical Dictionary of the U. S., Vol. V.

Land-Grant Colleges and Universities, Year Ended June 30, 1943. Circular No. 229, U. S. Office of Education. Washington, D. C., 1944.

Library of Congress. Miscellaneous records, papers, and letters.

Morrill, Justin S. "Educational Fund." Speech in the United States Senate, April 26, 1876.

Morrill, Justin S. "National Colleges." Speech in the United States Senate, December 5, 1872.

Morrill, Justin S. "On Granting Lands for Agricultural Colleges." Speech in the House of Representatives, April 20, 1858.

Morrill, Justin S. *Self-Consciousness of Noted Persons.* Boston, Ticknor and Company, 1887.

Parker, William Belmont. *Life and Public Services of Justin Smith Morrill.* Boston, Houghton Mifflin Company, 1924.

Wiley, Harvey W. *Lure of the Land.* New York, The Century Company, 1915.

Samuel W. Johnson

American Journal of Science and Arts, conducted by Professors B. Silliman, B. Silliman, Jr., and James D. Dana. New Haven, printed by E. Hayes, 1861.

Annual Report of the Smithsonian Institution, 1859. Washington, D. C., printed by Thomas H. Ford, 1860.

Bibliography of Samuel W. Johnson. Reprinted from *Bibliographies of the Present Officers of Yale University.* About 1892-93.

Browne, C. A. "Samuel W. Johnson," *Dictionary of American Biography,* X, 120.

Conover, Milton. *The Office of Experiment Stations, Its History, Activities and Organization.* Baltimore, Maryland, The Johns Hopkins Press, 1924.

Johnson, Samuel W. *Essays on Peat, Muck and Commercial Manures.* Hartford, Connecticut, Brown and Gross, 1859.

Johnson, Samuel W. *How Crops Feed.* New York, Orange Judd and Company, 1870.

Johnson, Samuel W. *How Crops Grow.* New York, Orange Judd and Company, 1868.

Lamb's Biographical Dictionary of the U. S., Vol. VI.

National Cyclopaedia of American Biography, Vol. VI.

Osborne, Elizabeth A. *From the Letter Files of S. W. Johnson.* New Haven, Yale University Press, 1913.

Osborne, Thomas B. *Biographical Memoir of Samuel William Johnson, 1830-1909.* Washington, D. C., National Academy of Science, July, 1911.

True, Alfred Charles, and Clark, Vinton Albert. *Agricultural Experiment Stations in the U. S.* Washington, D. C., Government Printing Office, 1900.

Vickery, Hubert Bradford. *Biographical Memoir of Thomas Burr Osborne.* Washington, D. C., National Academy of Science, 1931.

Wilbur Olin Atwater

Atwater, Dr. Helen W. "Bibliography of W. O. Atwater." Washington, D. C., Department of Agriculture Library. Typewritten manuscript.

Atwater, W. O. *Foods: Nutritive Value and Cost.* Washington, D. C., Government Printing Office, 1894.

Atwater, W. O., and Bryant, A. P. *Chemical Composition of American Food Materials.* Washington, D. C., Government Printing Office, 1899.

Atwater, W. O., and Langworthy, C. F. *A Digest of Metabolism Experiments.* Washington, D. C., Government Printing Office, 1897.

Conover, Milton. *Office of Experiment Stations.* Baltimore, Maryland, Johns Hopkins Press, 1924.

Dictionary of American History. Edited by James Truslow Adams. New York, Charles Scribner's Sons, 1940. 5 vols.

Dietary Studies at the University of Tennessee in 1895. Washington, D. C., Government Printing Office, 1896.

Harrow, Benjamin. "Wilbur Olin Atwater," *Dictionary of American Biography,* I, 417.

Lamb's Biographical Dictionary of the U. S.

National Cyclopaedia of American Biography, Vol. VI.

Physiological Aspects of the Liquor Problem, by Committee of 50 to Investigate the Liquor Problem. Boston, Houghton Mifflin Company, 1903.

Popular Science Monthly, Vol. LXXI, no. 5. New York, The Science Press, November, 1907.

Stemmons, Walter. *Connecticut Agricultural College—A History.* New Haven, Tuttle, Morehouse and Taylor Company, 1931.

Storrs Agricultural Experiment Station, Dedication of Atwater Laboratory. Storrs Bulletin 168, November, 1930.

U. S. Census Record of Burlington, Chittenden County, Vermont, 1850.

Seaman A. Knapp

Bailey, Joseph Cannon. *Seaman A. Knapp.* New York, Columbia University Press, 1945.

Cline, Rodney. *The Life and Work of Seaman A. Knapp.* Nashville, Tennessee, George Peabody College for Teachers, 1936.

Galloway, Beverly T., Chief, Bureau of Plant Industry. "Seaman Asahel Knapp," *Yearbook of the U. S. Department of Agriculture for 1911.* Washington, D. C., Government Printing Office, 1912.

Knapp, S. A. *Deep Fall Plowing and the Seed Bed* (1908), *Familiar Talks on Farming* (1908), *Farm Notes* (1909), *Crops for Southern Farms* (1910), *Farm Fertilizers* (1911), *The Corn Crop* (1911), all published in connection with Farmers' Co-operative Demonstration Work, Bureau of Plant Industry, Department of Agriculture. Washington, D. C., Government Printing Office.

Knapp, S. A. *Demonstration Work in Cooperation with Southern Farmers.* Farmers' Bulletin No. 319. Washington, D. C., Government Printing Office, 1908.

Knapp, S. A., Special Agent. *Demonstration Work on Southern Farms.* Farmers' Bulletin No. 422. Washington, D. C., Government Printing Office, 1910.

Knapp, S. A. *Rice Culture.* Farmers' Bulletin No. 417. Washington, D. C., Government Printing Office, 1910.

Knapp, Dr. S. A. *Rice Culture in the United States.* Farmers' Bulletin No. 110. Washington, D. C., Government Printing Office, 1900.

Martin, O. B. *Demonstration Work—Dr. S. A. Knapp's Contribution to Civilization.* San Antonio, Texas, The Naylor Company, 1941.

Mayo, Mr. and Mrs. A. M. "Dr. Seaman A. Knapp." Photostat, Calcasieu Parish, Louisiana, 1911 (?).

STEPHEN M. BABCOCK

Babcock, S. M. *Constitution of Milk.* Bulletin 18 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1889.

Babcock, S. M. *Constitution of Milk with Special Reference to Cheese Production.* Bulletin 61 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1897.

Babcock, S. M. *Directions for Using the Babcock Milk Test and the Lactometer.* Bulletin 36 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1893.

Babcock, S. M. *Metabolic Water: Its Production and Role in Vital Phenomena.* Research Bulletin 22 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1912.

Babcock, S. M. *New Method for the Estimation of Fat in Milk, Especially Adapted to Creameries and Cheese Factories.* Bulletin 24 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1890.

Babcock, S. M. *Variations in the Composition of Butter.* Bulletin 16 of Chemistry Division, Department of Agriculture. Washington, D. C., 1887.

Babcock, S. M., and Russell, H. L. *The Cheese Industry.* Bulletin 60 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1897.

Babcock, S. M., and Russell, H. L. Dairy Division of Bureau of Animal Industry, Department of Agriculture. *Cold Curing of Cheese.* Washington, D. C., Government Printing Office, 1906.

Babcock, S. M., Russell, H. L., and Decker, J. W. *Factory Tests for Milk.* Bulletin 67 of Wisconsin Agricultural Experiment Station. Madison, Wisconsin, 1898.

De Kruif, Paul. *Hunger Fighters.* New York, Harcourt, Brace and Company, 1928.

Hopkins, Andrew W., and Raisbeck, Agatha. "The Ten Master Minds of Dairying," *Successful Farming Magazine.* Des Moines, Iowa, Meredith Publishing Company, 1930.

Russell, Harry L. *Stephen Moulton Babcock, Man of Science.* Madison, Wisconsin, Wisconsin Alumni Research Foundation, 1943.

Theobald Smith

Eighth and Ninth Annual Reports of Bureau of Animal Industry. Washington, D. C., Government Printing Office, 1893.

Gage, Simon Henry. "Theobald Smith," *American Scholar,* Summer, 1935.

Medical Classics, Vol. I, no. 5, January, 1937. Baltimore, Maryland, Williams and Wilkins Company.

Salmon, D. E., and Smith, Theobald. *Actinomycosis, or Lumpy Jaw.* Bureau of Animal Industry, Circular No. 96, U. S. Department of Agriculture, 1904.

Salmon, Dr. D. E., and Smith, Dr. Theobald. *Anthrax in Cattle, Horses and Men.* Bureau of Animal Industry, Circular No. 71, U. S. Department of Agriculture, 1904.

Smith, Theobald, M.D. *Importance of Research in Animal Pathology to Agriculture.* University of Nebraska, September 24, 1920.

Smith, Theobald, M.D. "Preliminary Observations on the Micro-Organism of Texas Fever," *The Medical News,* December 21, 1899.

Smith, Theobald, M.D. *Tick Fever.* Farmers' Bulletin No. 1625, U. S. Department of Agriculture. Washington, D. C., Government Printing Office, 1930.

Smith, Theobald, and Kilborne, F. L. *Investigations into the Nature, Causation, and Prevention of Texas or Southern Cattle Fever.* Bureau of Animal Industry Bulletin No. 1, U. S. Department of Agriculture. Washington, D. C., Government Printing Office, 1893.

United States Census for 1860 and 1870. U. S. Archives, Washington, D. C.

Zinsser, Hans. *Biographical Memoir of Theobald Smith, 1859-1934.* Washington, D. C., National Academy of Science, 1936.

Mark A. Carleton

Carleton, Mark A. *Investigations of Rusts.* Bulletin No. 63, Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C., 1904.

Carleton, Mark A. *Lessons from the Grain-Rust Epidemic of 1904.* Bulletin No. 219, Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C., 1904.

Carleton, Mark A. *Macaroni Wheats.* Bulletin No. 3, Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C., 1901.

Carleton, Mark A. *Russian Cereals Adapted for Cultivation in the United States.* Bulletin No. 23, Division of Botany, U. S. Department of Agriculture. Washington, D. C., 1900.

Carleton, Mark A. *The Small Grains.* New York, The Macmillan Company, 1916.

Carleton, Mark A. *Ten Years Experience With the Swedish Select Oat.* Bulletin No. 182, Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C., 1910.

Carleton, Mark A., and Chamberlain, Joseph S. *The Commercial Status of Durum Wheat.* Bulletin No. 70, Bureau of Plant Industry, U. S. Department of Agriculture. Washington, D. C., 1904.

De Kruif, Paul. *Hunger Fighters.* New York, Harcourt, Brace and Company, 1928.

National Cyclopaedia of American Biography, Vol. XXIII.

Harvey W. Wiley

Browne, C. A. "Harvey Washington Wiley," *Dictionary of American Biography,* XX, 215-16.

Wiley, Anna Kelton. "... Its Great Founder," *Food, Drug, Cosmetic Law Quarterly,* Vol. I, no. 3. Published by Commerce Clearing House, dated September, 1946.

Wiley, Harvey W. *Foods and Their Adulteration.* Philadelphia, P. Blakiston's Sons and Company, 1917. Third edition.

Wiley, Harvey W. *Harvey W. Wiley—An Autobiography.* Indianapolis, Bobbs-Merrill Company, 1930.

Wiley, Harvey W., M.D. *The History of a Crime Against the Food Law.* Washington, D. C., Mills Building, Harvey W. Wiley, M.D., 1926.

Wiley, Harvey W. *The Lure of the Land.* New York, The Century Company, 1915.

Wiley, Harvey W., M.D. *Not by Bread Alone.* New York, Hearst's International Library Company, 1915.

Wiley, Harvey W. *Principles and Practice of Agricultural Analysis.* Easton, Pennsylvania, Chemical Publishing Company, 1906.

GEORGE H. SHULL

Agricultural Statistics 1946, Department of Agriculture. Washington, D. C., Government Printing Office, 1946.

Cereal Grains. Minneapolis, General Mills, Incorporated, 1941.

Corn, various issues, particularly Vol. III, 1947. New York, Corn Industries Research Foundation.

Corn Improvement. Reprint, *Yearbook Separate No. 1574,* Department of Agriculture, Washington, D. C., Government Printing Office, 1937.

Croy, Homer. *Corn Country.* New York, Duell, Sloan and Pearce, 1947.

The Farmer, December 14, 1940. St. Paul, Minnesota, The Webb Publishing Company.

Giles, Dorothy. *Singing Valleys.* New York, Random House, 1940.

Mossison, Gordon. "Grand Old Man of Hybrid Corn," *Seed World,* April 7, 1944. Chicago, National Seedsman Publications.

Wisconsin Agriculturalist and Farmer, December 14, 1940. Racine, Wisconsin.

AND THESE, TOO, SERVED

ABRAHAM LINCOLN

Barton, William E. *The Soul of Abraham Lincoln.* New York, George H. Doran Company, 1920.

Edwards, Everett E. *Lincoln and Agriculture.* Washington, D. C., Government Printing Office. Reprint.

Ross, Earle D. *Lincoln and Agriculture.* Selected from *Agricultural History,* 1929.

Sandburg, Carl. *Abraham Lincoln: The Prairie Years.* New York, Harcourt, Brace and Company, 1926. 2 vols.

HORACE GREELEY

DuBois, James T. *Galusha A. Grow.* New York, Houghton Mifflin Company, 1917.

Fahrney, Ralph R. *Horace Greeley and The Tribune.* Cedar Rapids, Iowa, Torch Press, 1936.

Greeley, Horace. *Address on Agriculture: What the Sister Arts Teach as to Farming.* Washington, D. C., Library of Congress, received 1873. 33 pages.

Greeley, Horace. *What I Know of Farming.* New York, G. W. Carleton and Company, 1871.

"H. G." at Chappaqua. By "A farmer poet." New York, John P. Jewett, 1872.

Linn, William A. *Horace Greeley.* New York, D. Appleton and Company, 1903.

Tilden, Arnold. *The Legislation of the Civil-War Period Considered as a Basis of the Agricultural Revolution in the United States.* Los Angeles, University of Southern California Press, 1937.

Luther Burbank

Burbank, Luther. *The Harvest of the Years.* Boston, Houghton Mifflin Company, 1927.

Burbank, Luther. *How Plants Are Trained to Work for Man.* New York, P. F. Collier and Son Company, 1921.

Burbank, Luther. *Partner of Nature.* New York, D. Appleton-Century Company, 1939.

Harwood, W. S. *New Creations in Plant Life.* New York, The Macmillan Company, 1921.

Jordan, David Starr, and Kellogg, Vernon L. *Scientific Aspects of Luther Burbank's Work.* San Francisco, A. M. Robertson, 1909.

David Grandison Fairchild

Fairchild, David. *Exploring for Plants.* New York, The Macmillan Company, 1930.

Fairchild, David. *Garden Islands of the Great East.* New York, Charles Scribner's Sons, 1944.

Fairchild, David. *The World Was My Garden.* New York, Charles Scribner's Sons, 1938.

Fairchild, David G. *Systematic Plant Introduction.* Washington, D. C., Government Printing Office, 1898.

Fairchild, David G. *The World Grows Round My Door.* New York, Charles Scribner's Sons, 1947.

Liberty Hyde Bailey

Bailey, L. H. *Cyclopaedia of American Agriculture.* New York, The Macmillan Company, 1907. 4 vols.

Bailey, L. H. *Forcing-Book.* New York, The Macmillan Company, 1903.

Bailey, L. H. *The Harvest.* New York, The Macmillan Company, 1927.

Bailey, L. H. *Principles of Agriculture.* New York, The Macmillan Company, 1919.

Bailey, L. H. *Talks Afield.* Boston, Houghton Mifflin and Company, 1885.

Fairchild, David. *Liberty Hyde Bailey, An Appreciation.* 1941.

Cyril George Hopkins

Davenport, E. "Grain Farming or Live Stock?" Five articles in *The Breeder's Gazette.* Chicago, 1910.

DeTurk, Ernest E. "Cyril George Hopkins," *Dictionary of American Biography,* IX, 207.

Hopkins, Cyril G. *Soil Fertility and Permanent Agriculture.* Boston, Ginn and Company, 1910.

In Memoriam, Cyril George Hopkins. Collected articles by Eugene Davenport, Dean of College of Agriculture at University of Illinois; Robert Stewart, Dean of College of Agriculture at University of Nevada; Ralph Allen, Soil Advisory Committee at University of Illinois; Brother Leo, Superintendent of the Farm at University of Notre Dame; and others. Urbana, Illinois, University of Illinois Press, 1922.

The Cokers

Coker, David R. *Does the American Cotton Industry Need the Plant Breeder?* Hartsville, South Carolina (undated pamphlet).

Coker, David R. *Report of Agricultural Commission to Europe.* Washington, D. C., U. S. Department of Agriculture, January 15, 1919. Pages 80-82.

Coker, William Chambers. *The Clavarias of the United States and Canada.* Chapel Hill, University of North Carolina Press, 1923.

Coker, William Chambers, and Beers, A. H. *The Boletaceae of North Carolina.* Chapel Hill, University of North Carolina Press, 1943.

Coker, William Chambers, and Matherly, Enid. *How to Know and Use the Trees.* University of North Carolina Extension Bulletin, Vol. III, no. 14. Chapel Hill, University of North Carolina Press, June 1, 1924.

Coker, William Chambers, and Totten, H. R. *Trees of the Southeastern States.* Chapel Hill, University of North Carolina Press, 1937.

Gaines, F. P. "James Lide Coker," *Dictionary of American Biography,* IV, 280-81.

James Lide Coker, Memorial Address, by J. W. Norwood, E. L. Wilkins, Margaret E. Cogswell, E. W. Sikes, F. R. Chambers. Hartsville, South Carolina, April 9, 1919, Founder's Day, Coker College.

Mims, Edwin. "The South Realizing Itself," *The World's Work,* October, 1911. Garden City, New York, Doubleday, Page and Company.

National Cyclopaedia of American Biography.

Norwood, J. W. "Major James Lide Coker." In appendix of *Rambles in the Pee Dee Basin, South Carolina,* by Harvey Toliver Cook, Vol. I. Columbia, South Carolina, The State Company, 1926.

Henry Ford

Borth, Christy. *Pioneers of Plenty.* New York, Bobbs-Merrill Company, 1939.

Ford, Henry. *My Life and Work.* Garden City, N. Y., Garden City Publishing Company, Incorporated, 1922.

Miller, James Martin. *Amazing Story of Henry Ford.* Chicago, M. A. Donohue and Company, 1922.

Simonds, William Adams. *Henry Ford.* Indianapolis, Bobbs-Merrill Company, 1946.

George Washington Carver

Borth, Christy. *Pioneers of Plenty.* New York, Bobbs-Merrill Company, 1939.

Bulletins and miscellaneous references at library of Tuskegee, Alabama.

Holt, Rackham. *George Washington Carver.* New York, Doubleday and Company, Incorporated, 1946.

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